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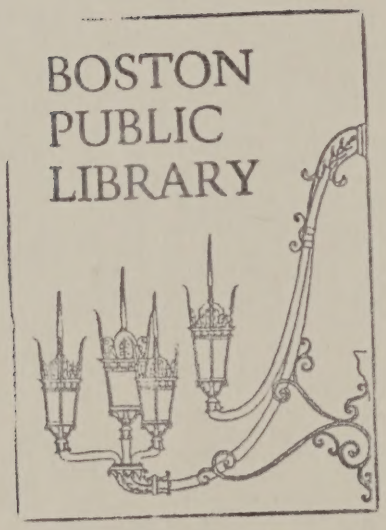
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THE COMMUNICATIONS–INFORMATION–KNOWLEDGE–INDUSTRIES

AND THE POTENTIAL FOR BOSTON

CITY OF BOSTON
Kevin H. White, Mayor

Boston Redevelopment Authority
Robert J. Ryan, Director

FIRST DRAFT
August 1982

THE COMMUNICATIONS-INFORMATION-KNOWLEDGE INDUSTRIES AND THE POTENTIAL FOR BOSTON

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First Draft
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Table of Contents

	Page
Boston's Potential	1
The National Outlook	3
Perspective for Boston	4
The Communications-Information-Knowledge Industries	6
Linkages and Inter-relationships	8
Concentration of C-I-K Business Services	9
Purpose, Scope, Sequence, Sources and Methods	10
Impacts	12
Industry Outlook	15
Boston's Office Industry and the Role of C-I-K Firms, 1977	16
The Pre-eminence of Boston and the Metro Area in Services and High Technology	18
Development Requirements	19
Footnotes	21
Appendix	
Tables 1-12	23
Other Sections	
Comments on Prospects, Inter-relationships, and Innovation for Selected Communication-Information-Knowledge Industries as Reported in the U.S. Industrial Outlook 1982.	36
Recent Reports of the Pre-Eminence of Services and High Technology in Boston and the Metro Area	54
Selected Industry Reports on Recent Trends and Future Prospects and Plans in the Communication-Information-Knowledge Industries	62
Specialized C-I-K Facilities; Two Summary Proposals	81

List of Tables

		Page
Tables		
1:	Communications-Information-Knowledge Industries, U.S., Boston, Boston Metro Area Number of Workers, 1979 and 1990	24
2:	Communications-Information-Knowledge Industries, U.S., Boston, and Boston Metropolitan Area, Percent Distribution of Employment, 1979 and 1990	25
3:	Employment Growth in Percent, 1979-1990, United States and Boston	26
4:	Percent Shares of Employment, 1979	27
5:	Gross Value of Output, U.S., (Dollars of Constant Value, 1972 Prices) 1979 and 1990	28
6:	Gross Value of Output, Boston (Suffolk County), (Dollars of Constant Value, 1972 Prices) 1979 and 1990	29
7:	Gross Value of Output, Boston Metropolitan Area, (Dollars of Constant Value, 1972 Prices) 1979 and 1990	30
8:	1977 Business Receipts ($1,000s) for Selected Services, Massachusetts and Boston	31
9:	Projected Impact of the Communication-Information-Knowledge Industries on Boston (1990)	32
10:	Value of Sales, 1982, and Five-Year Outlook for Selected Industries in the Communications-Information-Knowledge Field in the United States	33
11:	Sample Survey of Boston Office Industry Employment, 1977-1978; Comparison of Total and C-I-K Related Shares	34
12:	Role of Communications-Information-Knowledge Industry Firms Among Those Occupying Office Space in Boston, 1977-78	35

Boston's Potential

With its strong foothold and greater-than-national relative concentration in the more rapidly expanding communications-information-knowledge industries, Boston's potential is extraordinary. This potential has several dimensions.

Though C-I-K activities currently represent 37 percent of the City's employment and 28 percent of the value of production, their projected growth to 1990 will dominate. Employment in the C-I-K industries would grow by more than half, with an increment of 107,000 jobs by 1990, doubling the overall increase of the 1976-81 period, and accounting for more than ninety percent of the growth anticipated for the Boston economy. The value of sales of C-I-K enterprises, measured in dollars of constant value, would rise by 78 percent, and make up eighty percent of the projected sales growth of all enterprises. The estimated development cost for the expansion of the C-I-K industries foreseen, to 1990, would be upwards of $8 billion.

C-I-K firms currently account for two-thirds of total employment in Boston's office structures; their projected growth will require an additional 14.5 million square feet of office space, in the 1979-90 period, a one-third increase. Requirements for industrial space will expand by 2.4 million square feet, and 3,000 more hotel rooms will be needed.

There would be a marked flow of new fiscal resources for City government, with a projected rise in property tax yield of $92.5 million, by 1990, equal to one-fourth of the FY'82 levy.

The Potential of the Communications-Information-Knowledge Industries for Boston, 1979 to 1990

I. Jobs and Sales

Industry	Projected Increase in the Number of Jobs	Value of Sales (Millions of Constant (1972) Dollars)
Basic Communications Services	+ 4,824	+ $ 813
Direct Information Services	+30,779	+ 523
Other Information & Knowledge Services	+68,707	+ 1,250
Communications-Information Equipment	+ 2,438	+ 217
Total C-I-K Industries	+106,748	+ 2,802
All Industries	+113,287	+ $3,478

II. Estimated Development Cost--C-I-K Industries

$8 billion+

III. Development Impact

Increase in 1979-90 Requirements for:

Office Space	14.5 million sq. ft.
Industrial Space	2.4 million sq. ft.
Hotel Rooms	3,000 hotel rooms

Increase in Property Tax Yield $92.5 million (1990)

Sources: See Tables 1,6, and 9.

The National Outlook

The communications-information-knowledge industries are among the more rapidly growing areas of the national economy.[1] Moreover, looking forward to 1990, these industries, which accounted for one-fourth of total U.S. employment in 1979, are expected to increase at a greater rate than, and to expand their share of, national employment. The C-I-K industries are also projected to raise their value of production by seventy percent, in this period (in real terms, measured in dollars of constant value).[2]

The Communications-Information-Knowledge Industries in the United States

A. Employment

C-I-K as a Percent of Total Economy

1979	1990
24	28

Projected Growth, 1979-90, in Percent

Total Economy	25
C-I-K Industries	47

B. Gross Value of Production (Dollars of Constant Value)

C-I-K as a Percent of Total Economy

1979	1990
19	25

Projected Growth, 1979-90, in Percent

Total Economy	34
C-I-K Industries	70

Source: See Tables 1,2,3,4,5.

Within this group, individual component industries, such as radio, TV, and cable TV broadcasting, are anticipating even more spectacular rates of growth. The communications industries alone, representing the core and making up five percent of the C-I-K industries (in 1979) and consisting of radio, TV, and cable TV and telephone and telegraph, are projected to experience a growth in the gross value of production from $58 billion, in 1979, to $127 billion, in 1990 (in real terms),a more than doubling.[3]

The Communications Industries in the United States
(Radio, TV, Cable TV, Telephone and Telegraph,
SIC 481, 482, 483)

	1979	1990	Percent Change
Gross Value of Output (Billions of Dollars of Constant Value at 1972 Prices)	$58	$127	+119
Employment (Millions of Workers)	1.3	1.7	+ 32

Source: See Tables 1 & 5.

Perspective for Boston

For Boston, the implications for growth of the communications-information-knowledge industries are outstanding. Boston already has a substantial foothold in these industries, which make up an even greater share of the local economy than that for the nation as a whole (37 percent, in 1979, in comparison with 24 percent for the nation).[4] This is already the case even though there are also areas for prospective growth in which there is little present activity--cable TV, and related media services, for example. Analyses and projections suggest a prospect for an increase in share for the knowledge industries in Boston

(to 47 percent in 1990), as well as very substantial growth. The extraordinary perspective for Boston may be seen in the following comparison. With employment in the national economy as a whole projected to grow by 25 percent, in the 1979-90 period, and a related national C-I-K industries job growth of 47 percent anticipated, the Boston employment increase in the C-I-K industries is expected to expand by 51 percent.

Employment in the Communications-Information-Knowledge Industries in Boston and the Boston Metro Area, 1979 and 1990

C-I-K Industries as a Percent of Total

	1979	1990
Boston	37	47
Boston Metro Area	34	41

Projected Growth in C-I-K Industries, 1979-90 (in Percent)

Boston	51
Boston Metro Area	49

Source: See Tables 1, 2, & 3.

This comes about because of Boston's specialization in those components of the C-I-K industries projected to grow more rapidly.

The outlook for the nation's knowledge industries, and the potential for Boston, lend further substance to the concept of new areas of specialization and the establishment of a Boston Communications Technology Center. Boston is the sixth largest television market in the country. It is also the home of WCVB-TV/Metromedia, the fourth largest "network" in America, and WGBH-TV, a public television station known for its locally produced programs.

The state-of-the-art cable system now being installed in Boston also adds to Boston's likelihood as a production center for quality

television programming. Because Boston is at the center of America's high-technology industry, a unique opportunity exists to apply the research and development expertise of these businesses to Boston's 200-channel interactive cable system. In doing so, the Center could accommodate both cultural and commercial programming demands, particularly with the cultural and educational resources which exist in Boston.

The Communications-Information-Knowledge Industries

The communications-information-knowledge industries comprise a diversified grouping of communications, business and professional services, entertainment, finance, and related equipment production activities. A recent study reports that more than forty percent of the nation's workers are employed in "The Information Economy".[5] For the present study, a more limited definition is used, comprising industries which accounted for 24 percent of national employment, in 1979 (with a projected rise in share to 28 percent, in 1990).

The knowledge industries, as here defined, may be viewed in terms of four layers. At the center are the basic communications industries--radio, television, cable TV, and telephone and telegraph, which made up five percent of the nation's C-I-K industries employment, in 1979 (and six percent of that in Boston). Please see accompanying chart.

A second layer would include other direct communications-information industries--printing and publishing, computer and data processing and related business services, motion pictures and educational services--together accounting for 22 percent of the C-I-K industries.

Communications-Information-Knowledge Industries

A. Basic Communications Industries

1. Broadcasting (SIC 483)
   - Radio
   - TV
   - Cable TV
2. Telephone and Telegraph Services (SIC 481,482)

B. Direct Information Industries

1. Printing and Publishing (SIC 27)
2. Services
   - Business Services (SIC73)
     - Computer and Data Processing (SIC 737)
     - Mailing (SIC733)
     - News (SIC735)
     - Miscellaneous Business Services (SIC 739)
   - Motion Pictures (SIC 78)
   - Educational Services (SIC 82)

C. Other Communications-Information Industries

1. Finance
   - Banking and Credit (SIC 60,61)
   - Brokerage (SIC 62)
2. Business Services
   - Advertising (SIC 731)
   - Amusement and Recreation (SIC 79)
   - Credit Services (SIC 732)
3. Professional Services
   - Research (SIC 892,899)
   - Consulting, Architectural and Engineering (SIC 891)
4. Legal (SIC 81)
   - Accounting-Bookkeeping (SIC 893)
5. Health Services (SIC 80)
6. Business Services-Hotels (SIC 70)
   Personnel and Building Services (SIC 734,736)
7. Government (SIC 90) (one-fourth)

D. Communication-Information Equipment Production Industries

1. Computing and Office Equipment (SIC 357)
2. Telephone and Telegraph Equipment (SIC 366)
3. Electronic Equipment and Components (SIC 367)
4. Measuring and Controlling Instruments (SIC 381,382)
5. Photographic Equipment and Supplies (SIC 383,385,386)

A third layer would comprise the finance, banking, brokerage, advertising, amusement and recreation services. This group of C-I-K related services also encompasses research, consulting, architectural and engineering services, and legal and accounting services. Also included are business services and hotels, and mail order retail trade. An estimated one-fourth of government services is incorporated as a component of the C-I-K industries. Altogether this third layer makes up 64 percent of the C-I-K industries (including eighteen percent for government).

A fourth layer of communication-information equipment related industries comprises computing and office equipment, telephone and telegraph equipment, electronic equipment and components, measuring and controlling instruments, and photographic equipment and supplies, accounting for nine percent of C-I-K industries employment in the U.S. in 1979.

Linkages and Inter-relationships

What these industries have in common, in addition to their role as components of the C-I-K industries, is an extraordinary tapestry of inter-relationships and linkages. The direct information related services activities (layer 2) and the other information related services activities (layer 3) both serve and are served by the core communications industries (layer 1). And the communications-information equipment industries are both an essential ingredient of (as well as user of) the communications and information services industries.

These linkages also have a geographic dimension. In terms of the structure of the C-I-K industries, Boston has a higher relative concentration in the communications and information related services

activities (in comparison with the Metro Area and the U.S.), and is highly dependent on the communications-information equipment industries of the Boston Metro Area. In turn, the communications-information equipment industries of the Metro Area draw heavily on the professional and business services (office space) and hotels of the City of Boston.

Composition of the C-I-K Industries in Boston, the Metro Area and the U.S., 1979
(Employment, in Percent)

	Boston	Boston Metro Area	U.S.
Communications Services	6	5	5
Direct Information Services	28	26	22
Other Information & Knowledge	64	52	64
Equipment	2	17	9
Total C-I-K Industries	100	100	100

Source: See Table 2.

Concentration of C-I-K Business Services

Boston and the Metro Area have an extraordinary concentration of business services, especially those which are part of the C-I-K industries. In 1977(the latest Census of Selected Services year), Boston, with ten percent of the population and twenty percent of the employment of the State, accounted for thirty percent of the business receipts for selected services in Massachusetts.[6] But many services activities in Massachusetts were even more highly centered in the City of Boston.

1977 Business Receipts for Selected Services in Boston, As a Percent of Those in Massachusetts

Industry (Selected List)	
Hotels & Motels	28
Tax Preparation Service	79
Advertising	55
Credit & Collection	35
Direct Mail Advertising	45
Reproduction & Photocopy	37
Commercial Photography-Graphic Arts	43
Employment Agencies	32
Detective & Guard	71
Photofinishing Labs	33
Auto Rental & Leasing	42
Auto Parking	71
Motion Picture Distribution & Production	53
Motion Picture Theater	35
Theatrical Production & Bands	32
Prof. Sport Clubs	73
Legal Services	58
Engineering, Architectural & Survey Services	42
All Selected Services	30

Source: See Table 8.

The Boston Metro Area (including the City of Boston) accounts for an even greater concentration of business services within the state. A recent study reported that the Boston Labor Market Area (approximately the metro area) made up 81 percent of business services employment in Massachusetts in 1981.[7]

Purpose, Scope, Sequence, Sources and Methods

The purpose of the study is to identify the national outlook for the communication-information-knowledge industries and the potential for Boston and the metro area.

More specifically, the present report is designed to serve as background for the analysis of the feasibility for the development of a diversified communications-information-technology-TV production-media

center in Boston, and the implications of such a facility for the Boston and metro area economy.

The communications-information-knowledge industry is examined in a broad scope with detail to deal with both nationwide and citywide effects as well as specific industry and project significance.

Recently published (March 1982) national projections (1979-90) of employment and value of production, by industry detail (3-digit SIC), prepared by the U.S. government, were used for the basic analysis.[8] Please see Appendix tables. Of three alternative projections presented, the "High 1" was utilized and assumes a more thriving national economy. For 1990, for example, for the economy as a whole, "High 1" employment is five percent larger than "High 2" and seven percent larger than the "Low" alternative. For the base year 1979, comparable information on employment was available for Boston (Suffolk County) and for the Boston Metro Area (Suffolk, Essex, Middlesex, Norfolk and Plymouth Counties).[9] Employment in the C-I-K industries in Boston and the Metro Area was projected assuming a growth rate 1.2 times the national industry, on the theory that the latter represents a nationwide average while Boston and the Metro Area have a well-established specialization in the C-I-K industries. The C-I-K industries' value of production in Boston and the Metro Area were projected assuming the same 1979 production value per worker, by industry, as that for the U.S.

The projections of C-I-K industries employment and production value, in turn, provide the base for estimating the impact on Boston in terms of demand for office space and hotel rooms and the yield of property tax revenue.

These foregoing basic (3-digit SIC) analyses and projections are supplemented by up-to-date more detailed analyses of recent trends and developments, current profiles, and outlook projections (1 to 5 years) for an approximate dozen key C-I-K industries (at a 4-digit SIC level of detail).[10]

These analyses and projections, in turn, are further supplemented by current information on C-I-K industry trends, plans and projects as reported in industry publications.[11]

A summary of C-I-K industry firms occupying Boston office space, by (SIC) industry and employment level (in 1977) is presented, drawing on information gathered from the BRA survey of firms in the City's office buildings.[12]

Some implications on requirements for achieving the development potential projected are briefly noted.

Some possible next steps in analyzing the C-I-K industries potential are also cited.

Impacts

The C-I-K industries will have a significant effect on Boston's economy through a substantial increment in demand for office and industrial space, and hotel rooms, as well as a sizeable addition to property tax revenue.

The direct and indirect requirements for office space, in Boston, flowing from the projected growth of the C-I-K industries, in the 1979-90 period, is 14.5 million square feet of additional office space (exclusive of the office needs of the higher education, medical and government institutions as well as that of the (projected 1990) 53 percent of the City's economy made up of non-C-I-K activities). The

projected office space growth of 14.5 million square feet, in the 1979-90 period, is equivalent to more than one-third of Boston's total current stock of office space, public and private, of 40 million square feet, and may be compared to the 3.7 million square feet completed, since 1979, and the 6.4 million square feet currently underway and planned.[13]

The projected creation of 39,475 jobs in the communications, finance, and information and knowledge related services activities, with an estimated space requirement of 240 square feet per worker, signifies a direct need for an additional 9.5 million square feet of office space, in the 1979-90 period. See Table 9.

In addition, the projected growth in the C-I-K industries in the metro area, by 209,500 workers, over the same period, is expected to generate an indirect demand for communications, as well as business services, information and knowledge workers in Boston, in the equivalence of one new job in the City for each ten in the metro region. At 29,950 indirect jobs spawned, and a requirement of 240 square feet per worker, an additional indirect demand for five million square feet of office space in Boston may be anticipated in the 1979-90 period.

There will also be a significant increase in the requirements for industrial space. With a projected rise of 2,438 jobs, in the C-I-K equipment industries, and 3,508 jobs in printing and publishing--making a total of 5,946 new industrial jobs in the 1979-90 period, (in comparison with a Boston total of 54,955 manufacturing jobs in 1980) and a need of 400 square feet per worker, requirements for new industrial space are projected at 2.4 million square feet.

In Boston, fifty percent of hotel occupancy is business related (convention associated occupancy accounting for thirty percent, and tourist occupancy twenty percent) and an increase of 3,000 hotel rooms required is projected in line with the anticipated growth in C-I-K employment in Boston (direct effect) and the metro area (indirect effect), in the 1979-90 period. This may be compared with a current stock of approximately 8,200 hotel rooms, the construction of 2,210 hotel rooms since 1979, and 3,540 hotel rooms currently underway and planned.

Most important, perhaps, from the viewpoint of City Government's fiscal health, is an estimated increase in the property tax yield by $92.5 million, in 1990 (in comparison with the FY'82 levy of $441 million, and a projected FY'83 levy of $375 million).

Projected Impact of the
Communications-Information-Knowledge Industries on Boston

Office Space Demand (1979-90)	Millions of Sq. Ft.
Direct Effect	+9.5
Indirect Effect	+5.0
Total, Direct & Indirect Effect	+14.5
Industrial Space Demand	+2.4 millions of Sq. Ft.
Hotel Space Demand	+3,000 hotel rooms
Property Tax Yield (1990)	+ $92.5 million

Source: See Appendix Table 9.

Industry Outlook

The U.S. Bureau of Industrial Economics monitors and reports on recent trends, technology advances, and prospects for 200 national industries, including principal components of the communications-information-knowledge industries.[14] Their 1982 report is notable for the bright horizons foreseen for key elements of the C-I-K industries.

Projected 5-Year (1981-86) Annual Growth Rates in Value Of Sales (Dollars of Constant Value) for Selected Components of the C-I-K Industries in the U.S.

Industry	SIC Code	Annual Rates Of Growth In Percent
Broadcasting		
Radio	4832	12%
Television	4833	13%
Cable	4899	30%
Computing Equipment	3573	15%
Computer Services	737	
Electronic Equipment & Components		
Radio & Television Communications Equipment	3662	10%
Electronic Components	367	
Telephone & Telegraph Services	4811,4821	7%
Photographic Equipment & Supplies	3861	6.5%
Telephone & Telegraph Equipment	3661	5%
Instruments for		
Measurement,	3811	4%
Analysis,	3822-4-29	3%
and Control	3825-32	4%
Printing & Publishing	27	3%

Source: See Table 10

These anticipated annual rates of growth may be compared with the 3.6 percent rate of increase in C-I-K industry employment as a whole, and the 2.1 percent rate for total employment projected for the U.S. for the 1979-90 period. See Appendix Table 1.

Significant, also, is the cataloging of the extraordinary innovations in technology underway, and an emerging blending of linkages and inter-relationships between innovative equipment and the C-I-K services activities. For additional information on this subject, please see Appendix Section entitled "Comments on Prospects, Inter-relationships, and Innovation for Selected Communications-Information-Knowledge Industries as Reported in the U.S. Industrial Outlook 1982".

Recent C-I-K industry reports also highlight outstanding recent growth, a bright prospective outlook, a ferment of innovation underway, and a melting away of identity barriers as inter-industry linkages proliferate. Please see Appendix Section entitled "Selected Industry Reports on Recent Trends and Future Prospects and Plans in the Communications-Information-Knowledge Industries".

Boston's Office Industry and the Role of C-I-K Firms, 1977

Boston already has a firm foothold in these activities projected to grow most rapidly and a specialization in a range of C-I-K industries. In fact, C-I-K industry firms make up the greater share of the use of Boston's office space.

An extensive survey of the firms occupying Boston's office space, in 1977, found that C-I-K firms accounted for 64 percent of all firms and 66 percent of all employment in Boston's office structures.

Role of C-I-K Firms in Boston's Office Buildings, 1977-78

SIC	Number of Firms	Employment		
		Boston Area	City of Boston	Survey Location
I. Summary of Sample of Firms Surveyed				
C-I-K	313	10,379	10,217	9,543
Non-C-I-K	178	26,467	15,577	4,936
Total	492	36,846	25,794	14,479
C-I-K as % of Total	63.7%	28.2%	39.6%	65.9%

II. Universe Estimate of Employment and Firms in Boston's Office Buildings, 1977-78*

	Firms	Employment
Total	5,020	147,238

* Sample covered 9.8% of Boston's total office space.

Source: See Appendix Tables 11 and 12.

In effect, the C-I-K firms occupying space in Boston's office structures made up an estimated 97,030 workers of a total office industry employment level of 147,238 and a citywide employment level of 505,742, accounting for one out of five workers in the City as a whole.

Every important branch of C-I-K services industries are represented in Boston's office structures. The top ten are noted. For full details, see Appendix Table 12.

The Top Ten C-I-K Industry Firms Occupying Boston's Office Structures, 1977

SIC Code		Rank by Employment Size
48	Communications, including Telephone & Telegraph, Radio & Television, Cable TV	1
62	Brokerage	2
89	Professional Services, including Engineering, Architecture, Planning & Design Consultants	3
81	Legal Services	4
73	Business Services, including Advertising, Data Processing, Employment Services	5
90	Government	6
60	Banking	7
27	Printing & Publishing	8
80	Health Services	9
61	Credit	10

See Table 12

The Pre-Eminence of Boston and the Metro Area in Services and High Technology

The leading role of Boston and the Metro Area in services activities and high technology industry has helped them excel in recent economic performance, in comparison with other areas, and this phenomenon has been the subject of several reports by qualified observers.

Business Week recently noted that Boston, New York and Philadelphia, with unemployment rates less than those of the nation as a

whole, have experienced a significant transformation of their economic structure, favoring the growth of services activities.[15]

A recent New York Times article reported on the job creation success of high technology industry in the Boston Metro Region and the Silicon Valley of California, and credited a combination of research universities, amenities, innovators, and venture capital with creating the critical mass which led to success.[16]

A recent study of the computer industry in New England documents how the industry grew, and concluded that the Region remains a good place to start up or expand a computer company. "New companies and R & D facilities are attracted by the infrastructure and agglomeration advantages of Boston and the City's heavy concentration of educational institutions....The combination of access to highly skilled professional labor and low-wage but skilled workers makes New England an attractive area for companies whose products are sufficiently unstandardized that locating production near R & D facilities remains an advantage...Just in Massachusetts alone, in 1979, 300 computer-related firms were located within two miles of MIT and 156 of the 216 high-tech firms counted in another report as being in the greater Boston area came from the Institute's laboratories and departments."[17]

Development Requirements

As the foregoing information, analyses and projections suggest, Boston has a good potential in one of the nation's most rapidly growing areas, the communications-information-knowledge industries. A pre-eminent track record, a strong existing base, a concentration of universities and their talent and ambience, amenities and attractiveness, agglomeration and infrastructure, skilled professionals

and competitive semi-skilled labor, a thriving and cosmopolitan city and metro region, innovators and venture capital, and a broad range of C-I-K related and rapidly growing services activities favor Boston's prospects.

Essential to the fulfillment of opportunity will be the role of public and private leadership in continuing to make Boston an attractive place to live and work, and to foster the development and finance of the C-I-K industries. Attention could focus on the following:

1. Facilities Requirements

   A specialized facility could represent an important initiative in spurring the C-I-K industries concept. Please see Appendix Sections presenting summary proposals for a "Bay City Centre" and a "Communications Technology Center".

2. Public Infrastructure and Public Services

   As the recent reports of Business Week, the New York Times, and the Joint Center have noted, good public infrastructure and public services are essential to the amenities that attract the relatively footloose C-I-K industries to Boston and the Metro Area. The deterioration since 1980, forced by tax limitation legislation, must be countered if this area is to remain attractive.

3. Education and Manpower Training

   The flourishing of the C-I-K industries in the Boston area will require a continued cadre of trained semi-skilled workers and educated unskilled workers. A heroic public and private effort is needed to mount the quality of education and manpower training needed.

Should the circumstances warrant, the following next steps in studying the potential of the C-I-K industries in Boston might be taken.

1. A survey of the C-I-K industries in Boston and the Metro Area, and their future plans and potential. (This would be a substantive long-term undertaking).

2. Analysis of the Need for, and Feasibility of Specialized Facilities.

3. A review of how the public sector planning and development role in relation to the C-I-K industries might be funded.

Footnotes

[1] Communication News, 1982, Various Issues;

Science, Vol. 209, July 4, 1980, article by Anthony G. Oettinger, Chairman of the Program on Information Resources Policy, Harvard University, "Information Resources: Knowledge and Power in the 21st Century";

U.S. Dept. of Commerce, Bureau of Industrial Economics, 1982 U.S. Industrial Outlook, for 200 Industries, with Projections for 1986, January 1982.

[2] U.S. Dept. of Labor, Bureau of Labor Statistics, Economic Projections to 1990, Bulletin 2121, March 1982.

[3] U.S. Dept of Labor, Ibid.;
U.S. Dept. of Commerce, op.cit.;
Communications News, op.cit.

[4] U.S. Dept. of Commerce, Bureau of the Census, County Business Patterns, 1979, Massachusetts, March 1981.

[5] M.U. Porat, U.S. Dept. of Commerce, Office of Telecommunications, The Information Economy: Definition and Measurement, May 1977 (reported in the article by Oettinger, in Science. op.cit.

[6] U.S. Bureau of the Census, 1977 Census of Services Industries, Massachusetts.

[7] Massachusetts Division of Employment Security, Business Support Services Employment in Massachusetts, March 1982, Table 4.

[8] U.S. Bureau of Labor Statistics, Economic Projections to 1990, op.cit.

[9] U.S. Bureau of the Census, County Business Patterns, 1979, Massachusetts, op. cit.

[10] U.S. Bureau of Industrial Economics, 1982 Industrial Outlook for 200 Industries with Projections for 1986, op. cit.

[11] Communication News, various issues; other industry publications; special reports.

[12] Boston Redevelopment Authority, The Office Industry Survey-Part II-Analysis of Office Tenant Responses, March 1979.

[13] Boston Redevelopment Authority, Robert J. Ryan, Director, Budget Perspective for Fiscal Year 1983,July 1982.

[14] U.S. Bureau of Industrial Economics, op.cit.

[15] Business Week, July 5, 1982, article entitled "Services Prop Up The Old Factory Cities"; see Appendix Section.

[16] Fox Butterfield, New York Times, August 8, 1982, article entitled "2 Areas Show a Path to Jobs in Technology"; see Appendix Section.

[17] Joint Center for Urban Studies of MIT and Harvard, Joint Center Report, May 1982,, article entitled "Computer Manufacturing in New England", summarizing a study by Sarah Kuhn, Computer Manufacturing in New England; Structure, Location, and Labor in a Growing Industry.

TABLES*

* Note: The principle sources for Tables 1 through 7 are:

U.S. Department of Labor, Bureau of Labor Statistics, Economic Projections to 1990, Bulletin 2121, March 1982, and
U.S. Dept. of Commerce, Bureau of the Census, County Business Patterns, 1979, Massachusetts, March 1981.
Boston and Metro Area C-I-K industries are projected as a function of those for the nation, as described in the text. Boston Metro Area projections for "all industries" are derived from: U.S. Bureau of Economic Analysis, 1980 OBERS BEA Regional Projections, Vol. 4, Region 1, New England, July 1981.
Boston projections for "all industries" are by the Boston Redevelopment Authority, Boston and the MAPC Region, Center of a Resurgent New England; Population and Employment Projections, 1990, 2000, 2010, December 1981.

Table 1: COMMUNICATIONS-INFORMATION-KNOWLEDGE INDUSTRIES, U.S., BOSTON, BOSTON METRO AREA
NUMBER OF WORKERS, 1979 AND 1990

SIC	Industry & Components	1979 U.S. (000s)	1979 Boston (Suff.)	1979 Metro Area	1990 U.S. (000s)	1990 Boston (Suff.)	1990 Metro Area
A.	Basic Communications Industries						
483,9	Broadcasting	193	1,750	3,004	277	2,664	4,572
481,2	Telephone & Telegraph Serv.	1,121	10,971	26,463	1,454	14,881	35,894
	Sub-total	1,314	12,721	29,467	1,731	17,545	40,466
B.	Direct Information Industries						
27	Printing & Publishing	1,306	13,228	33,256	1,595	16,736	42,075
732-9	Misc. Business Services (.80)	2,512	17,297	52,979	3,806	27,959	85,643
78	Motion Pictures	308	1,249	2,816	329	1,351	3,046
82	Educational Services	1,403	25,857	80,273	2,149	42,364	131,519
	Sub-total	5,529	57,631	169,594	7,879	88,410	262,283
C.	Other Communications-Info. Serv.						
60	Banking	1,492	15,455	31,363	2,013	21,928	44,498
61,2	Credit & Brokerage	898	7,126	12,246	1,329	11,231	19,300
731	Advertising	166	1,443	2,064	213	1,933	2,765
79	Amusement & Recreation	761	3,051	9,481	1,042	4,402	13,679
891-9	Misc. Professional Services	1,720	12,676	29,062	2,413	29,377	48,859
81	Legal		7,125	9,985			
80	Health Services	4,024	49,025	138,069	8,741	86,500	243,609
70	Hotel	1,543	5,046	13,292	2,126	7,335	19,321
734,6	Misc. Business Services (.20)	629	4,471	11,276	951	7,209	18,167
596	Retail-Direct Mail & Phone	250	2,154	7,020	325	2,929	9,547
90,9	Government	4,490	24,894	71,963	5,004	28,329	81,894
	Sub-total	15,973	132,466	335,821	24,157	201,173	501,639
D.	Communications-Information Equip.						
357	Computing & Office	586	1,750	20,146	929	2,978	34,288
366	Telephone & Telegraph	641	324	33,692	784	411	42,708
367	Electronic & Components	605	544	18,188	880	841	28,119
381,2	Measuring & Controlling	218	1,575	20,420	296	2,252	29,192
383,5	Optical & Opthalmic	82	360	5,902	102	465	7,630
386	Photographic and Supplies	134	157	11,405	165	201	14,566
	Sub-total	2,266	4,710	109,753	3,156	7,148	156,503
	Total (C-I-K Industries)	25,082	207,528	644,635	36,923	314,276	960,891
	Total (All Industries)	104,120	555,513	1,918,612	130,665	668,800	2,357,600

Table 2: COMMUNICATIONS-INFORMATION-KNOWLEDGE INDUSTRIES, U.S., BOSTON, AND BOSTON METROPOLITAN AREA, PERCENT DISTRIBUTION OF EMPLOYMENT, 1979 AND 1990

SIC	Industry & Components	1979 U.S.	1979 Boston (Suff.)	1979 Metro Area	1990 U.S.	1990 Boston (Suff.)	1990 Metro Area
A.	Basic Communications Industries						
483,9	Broadcasting	.8%	.8%	.5%	.8%	.8%	.5%
481,2	Telephone & Telegraph Serv.	4.5	5.3	4.1	3.9	4.7	3.7
	Sub-total	5.3	6.1	4.6	4.7	5.5	4.2
B.	Direct Information Industries						
27	Printing & Publishing	5.2	6.4	5.1	4.3	5.3	4.4
732-9	Misc. Bus. Serv. (.80)	10.0	8.4	8.2	10.3	8.9	8.9
78	Motion Pictures	1.2	.6	.4	.9	.4	.3
82	Educational Services	5.6	12.5	12.5	5.8	13.5	13.7
	Sub-total	22.0	27.9	26.2	21.3	28.1	27.3
C.	Other Communications-Info. Serv.						
60	Banking	5.9	7.4	4.9	5.5	7.0	4.6
61,2	Credit & Brokerage	3.6	3.5	1.9	3.6	3.6	2.0
731	Advertising	.7	.7	.3	.6	.6	.3
79	Amusement & Recreation	3.0	1.5	1.5	2.8	1.4	1.4
891-9	Misc. Professional Serv.	6.9	6.1	4.6	6.5	9.3	5.1
81	Legal		3.4	1.5			
80	Health Services	16.0	23.6	21.4	23.7	27.5	25.4
70	Hotel	6.2	2.4	2.1	5.6	2.3	2.0
734,6	Misc. Bus. Serv. (.20)	2.5	2.2	1.7	2.6	2.3	1.9
596	Retail-Direct Mail & Phone	1.0	1.0	1.1	.9	.9	1.0
90,9	Government	17.9	12.0	11.1	13.6	9.0	8.5
	Sub-total	63.7	63.8	52.1	65.4	63.9	52.2
D.	Communications-Info. Equipment						
357	Computing & Office	2.3	.8	3.1	2.5	0.9	3.6
366	Telephone & Telegraph	2.6	.2	5.2	2.1	0.1	4.4
367	Electronic & Components	2.4	.3	2.8	2.4	0.3	2.9
381,2	Measuring & Controlling	.9	.8	3.2	0.8	0.7	3.0
383,5	Optical & Opthalmic	.3	.2	.9	0.3	0.1	.8
386	Photographic & Supplies	.5	.1	1.8	0.4	0.1	1.5
	Sub-total	9.0	2.4	17.0	8.5	2.2	16.2
Total	(C-I-K Industries)	100.0	100.0	100.0	100.0	100.0	100.0

Table 3: EMPLOYMENT GROWTH IN PERCENT, 1979-1990, UNITED STATES AND BOSTON

SIC	Industry & Components	U.S.	Boston (Suffolk)
A.	Basic Communications Industries		
483,9	Broadcasting	43.5%	52.2%
481,2	Telephone & Telegraph Services	29.7	35.6
	Sub-total	31.7	37.9
B.	Direct Information Services		
27	Printing & Publishing	22.1	26.5
732-9	Misc. Bus. Services (.80)	51.3	61.6
78	Motion Pictures	6.8	8.2
82	Educational Services	53.2	63.8
	Sub-total	42.5	53.4
C.	Other Communications-Info. Services		
60	Banking	34.9	41.9
61,2	Credit & Brokerage	48.0	57.6
731	Advertising	28.3	34.0
79	Amusement & Recreation	36.9	44.3
891-9	Misc. Professional Services	40.3	48.4
81	Legal		
80	Health Services	63.7	76.4
70	Hotel	37.8	45.4
734,6	Misc. Business Services (.20)	51.3	61.6
596	Retail-Direct Mail & Phone	30.0	36.0
90,9	Government	11.5	13.8
	Sub-total	51.2	51.9
D.	Communications-Information Equipment		
357	Computing and Office	58.5	70.2
366	Telephone & Telegraph	22.3	26.8
367	Electronic & Components	45.5	54.6
381,2	Measuring & Controlling	35.8	43.0
383,5	Optical & Opthalmic	24.4	29.3
386	Photographic & Supplies	23.1	27.7
	Sub-total	39.3	51.8
Total	(C-I-K Industries)	47.2	51.4
Total	(All Industries)	25.5%	20.4%

Table 4: PERCENT SHARES OF EMPLOYMENT, 1979

SIC	Industry and Components	Boston as a % of U.S.	Metro Boston as a % of U.S.	Boston as a % of Metro Boston
A.	Basic Communications Industries			
483,9	Broadcasting	.9%	1.6%	58.3%
481,2	Telephone & Telegraph Services	1.0	2.4	41.5
	Sub-total	1.0	2.2	43.2
B.	Direct Information Services			
27	Printing & Publishing	1.0	2.5	39.8
732-9	Misc. Business Services (.80)	.7	2.1	32.6
78	Motion Pictures	.4	.9	44.4
82	Educational Services	1.8	5.7	32.2
	Sub-total	1.0	3.1	34.0
C.	Other Communications-Info. Services			
60	Banking	1.0	2.1	49.3
61,2	Credit and Brokerage	.8	1.4	27.6
731	Advertising	.9	2.1	69.9
79	Amusement & Recreation	.4	1.2	32.2
891-9	Misc. Professional Services	1.2	2.3	50.7
81	Legal			
80	Health Services	.9	2.6	35.5
70	Hotel	.3	.9	38.0
734,6	Misc. Business Services (.20)	.7	2.1	39.7
596	Retail-Direct Mail & Phone	.9	2.8	30.7
90-9	Government	.6	1.6	34.6
	Sub-total	.8	2.1	39.4
D.	Communications-Information Equipment			
357	Computing & Office	.3	3.4	8.7
366	Telephone & Telegraph	.05	5.3	1.0
367	Electronic & Components	.09	3.0	3.0
381,2	Measuring & Controlling	.7	9.4	7.7
383,5	Optical & Opthalmic	.4	7.2	6.0
386	Photographic & Supplies	.1	8.5	1.4
	Sub-total	.2	4.8	4.3
Total	(C-I-K Industries)	.8	2.6	32.2

Table 5: GROSS VALUE OF OUTPUT, U.S., (Dollars of Constant Value, 1972 Prices) 1979 AND 1990

SIC	Industry and Components	Millions of Dollars		Percent Distribution		Growth in Percent
		1979	1990	1979	1990	1979-1990
A.	Basic Communications Industries					
483,9	Broadcasting	3,554	7,513	0.8%	1.0%	111.4%
481,2	Telephone & Telegraph Serv.	54,461	119,993	11.7	15.2	120.3
	Sub-total	58,015	127,506	12.5	16.2	119.8
B.	Direct Information Industries					
27	Printing & Publishing	35,000	54,598	7.5	6.9	56.0
732-9	Misc. Business Services (.80)	46,438	66,800	10.0	8.5	43.8
78	Motion Pictures	7,550	12,055	1.6	1.5	59.7
82	Educational Services	13,671	17,791	2.9	2.3	30.1
	Sub-total	102,659	151,244	22.0	19.2	47.3
C.	Other Communications-Info. Services					
60	Banking	33,212	48,701	7.2	6.2	46.6
61,2	Credit and Brokerage	16,383	26,699	3.5	3.4	63.0
731	Advertising	4,138	6,487	0.9	0.8	56.8
79	Amusement & Recreation	11,957	21,435	2.6	2.7	79.3
891-9	Misc. Professional Services	39,607	56,847	8.5	7.2	43.5
81	Legal	73,817	123,936	15.9	15.7	67.9
80	Health Services	9,995	15,763	2.2	2.0	57.7
70	Hotel	11,610	16,700	2.5	2.1	43.8
734,6	Misc. Business Services (.20)	3,562	5,233	0.8	0.7	46.9
596	Retail-Direct Mail & Phone	5,409	8,235	1.2	1.0	52.2
90,9	Government	209,690	330,036	45.3	41.8	57.4
	Sub-total					
D.	Communications-Information Equipment					
357	Computing & Office	28,912	67,099	6.2	8.5	132.1
366	Telephone & Telegraph	24,690	42,677	5.3	5.4	72.9
367	Electronic & Components	24,207	42,821	5.2	5.4	76.9
381,2	Measuring & Controlling	5,639	9,108	1.2	1.2	61.5
383,5	Optical & Opthalmic	2,002	3,856	0.4	0.5	92.6
386	Photographic & Supplies	8,036	14,747	1.7	1.9	83.5
	Sub-total	93,486	180,308	20.0	22.9	92.9
Total (C-I-K Industries)		463,849	789,814	100.0	100.0	70.1
Total (All Industries)		2,387,108	3,201,732	19.4% (C-I-K % All)	24.7% (C-I-K % All)	34.1%

Table 6: GROSS VALUE OF OUTPUT, BOSTON (SUFFOLK COUNTY), (Dollars of Constant Value, 1972 Prices) 1979 AND 1990

SIC	Industry and Components	Thousands of Dollars		Percent Distribution		Growth in Percent
		1979	1990	1979	1990	1979-1990
A.	Basic Communications Industries					
483,9	Broadcasting	32,226	75,306	.9	1.2	133.7
481,2	Telephone & Telegraph Serv.	533,004	1,302,449	14.9	20.4	144.4
	Sub-total	565,230	1,377,755	15.8	21.6	143.8
B.	Direct Information Industries					
27	Printing & Publishing	354,497	592,719	9.9	9.3	67.2
732-9	Misc. Business Services	319,320	490,847	9.0	7.7	53.7
78	Motion Pictures	30,617	52,551	.9	.8	71.6
82	Educational Services	251,951	342,955	7.1	5.4	36.1
	Sub-total	956,385	1,479,072	26.9	23.2	54.7
C.	Other Communications-Info. Serv.					
60	Banking	344,028	536,409	9.6	8.4	55.9
61,62	Credit & Brokerage	130,007	228,292	3.6	3.6	75.6
731	Advertising	35,971	60,489	1.0	.9	68.2
79	Amusement & Recreation	47,937	93,554	1.3	1.5	95.2
891-9	Misc. Professional Services	455,958	693,967	12.7	10.9	52.2
81	Legal	677,575	1,229,662	19.0	19.3	81.5
80	Health Services	32,688	55,321	.9	.9	69.2
70	Hotel	82,539	122,712	2.3	1.9	48.7
734	Misc. Business Services	30,733	47,956	.9	.8	56.0
596	Retail-Direct Mail & Phone	29,997	48,788	.8	.8	62.6
90,9	Government	1,867,433	3,117,150	52.1	49.0	66.9
	Sub-total					
D.	Communications-Information Equipment					
357	Computing & Office	86,410	223,386	2.4	3.5	158.5
366	Telephone & Telegraph	12,480	23,397	.3	.4	87.5
367	Electronic & Components	21,767	41,853	.6	.7	92.3
381,2	Measuring & Controlling	40,741	70,807	1.1	1.1	73.8
383,5	Optical & Opthalmic	8,789	18,556	.2	.3	111.1
386	Photographic & Supplies	9,415	18,849	.3	.3	100.2
	Sub-total	179,602	396,848	4.9	6.3	121.0
Total (C-I-K Industries)		3,568,650	6,370,825	100.0	100.0	78.5

Table 7: GROSS VALUE OF OUTPUT, BOSTON METROPOLITAN AREA, (Dollars of Constant Value, 1972 Prices) 1979 AND 1990

SIC	Industry and Components	Thousands of Dollars		Percent Distribution		Growth in Percent
		1979	1990	1979	1990	1979-1990
A.	Basic Communications Industries					
483,9	Broadcasting	55,319	129,169	.4	.6	133.7
481,2	Telephone & Telegraph Serv.	1,285,652	3,141,619	10.0	13.1	144.4
	Sub-total	1,340,971	3,270,888	10.4	13.7	143.9
B.	Direct Information Industries					
27	Printing & Publishing	891,228	1,490,132	6.9	6.2	51.9
732-9	Misc. Business Services (.80)	948,970	1,448,886	7.4	6.1	52.7
78	Motion Pictures	69,029	118,481	.5	.5	71.6
82	Educational Services	782,180	1,064,703	6.1	4.4	36.1
	Sub-total	2,691,407	4,122,202	20.9	17.2	53.2
C.	Other Communications-Inform. Ind.					
60	Banking	698,140	1,088,540	5.4	4.6	55.9
61,2	Credit & Brokerage	223,416	392,318	1.7	1.6	75.6
731	Advertising	51,451	86,521	.4	.4	68.2
79	Amusement & Recreation	148,965	290,720	1.2	1.2	95.2
891-9	Misc. Professional Services	922,416	1,403,916	7.2	5.8	52.2
81	Legal	1,908,252	3,463,096	14.8	14.4	81.5
80	Health Services	86,106	145,726	.7	.6	69.2
70	Hotel	237,242	362,222	1.8	1.5	52.7
734-6	Misc. Business Services (.20)	100,161	156,291	.8	.7	56.0
596	Retail-Direct Mail & Phone	86,715	141,137	.7	.6	62.8
90,9	Government	4,462,864	7,530,487	34.7	31.4	68.7
	Sub-total					
D.	Communications-Information Equipment					
357	Computing & Office	994,749	2,571,625	7.7	10.8	158.5
366	Telephone & Telegraph	1,297,748	2,433,018	10.1	10.2	87.5
367	Electronic & Components	727,738	1,399,295	5.7	5.9	92.3
381,2	Measuring & Controlling	528,204	918,019	4.1	3.8	73.8
383,5	Optical & Opthalmic	144,097	304,218	1.1	1.3	111.1
386	Photographic & Supplies	683,958	1,369,384	5.3	5.7	100.2
	Sub-total	4,376,494	8,995,559	34.0	37.7	105.5
	Total (C-I-K Industries)	12,871,736	23,919,136	100.0	100.0	85.8
	Total (All Industries)	44,290,819	71,529,958	29.1	33.4	61.5

Table 8: 1977 BUSINESS RECEIPTS ($1,000s) FOR SELECTED SERVICES, MASSACHUSETTS AND BOSTON

SIC	TYPE OF BUSINESS	MASSACHUSETTS	BOSTON	BOSTON AS % OF MASS.	FORECASTED ANNUAL GROWTH RATES(%)
7011	HOTELS & MOTELS	333,426	93,075	27.9	3.72
721	LAUNDRY-LINEN & DRY CLEAN	148,403	32,503	21.9	2.43
722	PHOTO STUDIOS & PORTRAIT	26,827	3,916 e	14.6	2.43
723.4	BEAUTY & BARBER SHOPS	140,968	18,939	13.4	2.43
725	SHOE REPAIR & HAT CLEAN	6,045	1,814	30.0	2.43
729	TAX PREPARATION SERVICE *	7,005	5,551 f	79.2	2.43
729	MISC. PERSONAL SERVICES *	47,041	13,171 fh	28.0	2.43
729	HEALTH CLUBS & SALONS *	16,122	4,708 h	29.2	2.43
731	ADVERTISING	98,134	54,384	55.4	2.43
732	CREDIT & COLLECTION *	12,147	4,287 f	35.3	2.43
7331	DIRECT MAIL ADVERT. *	34,403	15,619 ee	45.4	2.43
7332.9	REPRO & PHOTOCOPY *	20,990	7,703 e	36.7	2.43
7333	COMM.PHOT-ART GRAPHIC *	52,387	22,568 e	43.1	3.76
734	SERVICES TO BLDGS	136,959	42,056	30.7	2.43
7361	EMPLOYMENT AGENCIES *	30,181	9,690	32.1	2.43
737	COMPUTER & DATA PROC.	308,872	53,352	17.3	2.43
7391	COMMERCIAL R & D *	184,451	11,773 f	6.4	2.43
7392	MANAGE. CONSULT. & P.R.	425,043	74,135	17.4	3.76
7393	ARMORED CAR SERVICES *	9,845	2,875 h	29.2	2.43
7393	ALARM SERVICES *	12,042	3,516 h	29.2	2.43
7393	DETECTIVE & GUARD *	65,963	46,857	71.0	2.43
7394	EQUIPMENT RENT & LEASING	116,135	20,236	17.4	2.43
7395	PHOTOFINISHING LABS *	41,662	13,858 e	33.3	2.43
7397	COMMERCIAL TESTING LABS *	15,395	1,014	6.6	2.43
7399	SIGN PAINTING SHOPS *	1,825	503 f	27.6	2.43
7399	PHONE ANSWERING SERVICE *	9,850	1,242 fh	12.6	2.43
7399	WATER SOFTEN SERVICE *	1,231	359 h	29.2	2.43
7399	PACKAGING & LABELING *	6,804	1,987 hf	29.2	2.43
7399	OTHER BUSINESS SERVICE *	92,345	20,987 f	22.7	2.43
7399	INTERIOR DESIGN *	13,147	3,772	28.7	2.43
751	AUTO RENTAL & LEASING	138,915	58,917	42.4	2.43
752	AUTO PARKING	26,056	18,427	70.7	2.43
753	AUTO REPAIR SERVICE	341,526	37,917	11.1	3.86
754	AUTO SERVICE - NOT REPAIR	25,297	2,965	11.7	2.43
76	MISC. REPAIR SERVICE	221,249	33,616	15.2	2.43
781.2	MOTION PICT. DIST. & PROD	65,467	34,501 e	52.7	1.52
783	MOTION PICTURE THEATER	82,167	28,841 e	35.1	1.52
792	THEAT. PROD. & BANDS	47,361	15,332	32.4	1.52
793	BOWLING & BILLIARDS	31,395	3,642 e	11.6	3.60
7941	PROF. SPORTS CLUBS *	44,454	32,540 ee	73.2	3.60
7948	RACING & RACETRACKS *	46,925	0 g	0.0	3.60
7992	GOLF COURSES - NOT MUNI.	10,386	0	0.0	3.60
7996	AMUSEMENT PARKS *	14,202	0 g	0.0	3.60
7997	MEMB. SPORTS & REC. CLUBS	38,395	1,104	2.9	3.60
81	LEGAL SERVICES	546,124	315,308	57.7	3.76
891	ENG.- ARCH. & SURVEY.	563,986	235,329	41.7	3.76
	TOTAL	4,659,553	1,404,889	30.2	

* ESTABLISHMENTS WITH PAYROLL ONLY
e ESTIMATED BASED ON BOSTON % OF STATE PAYROLL
f BASED ON BOSTON % OF NUMBER OF STATE ESTABLISHMENTS
h ESTIMATED BASED ON BOSTON'S SHARE OF STATE BUSINESS RECEIPTS FOR ALL SELECTED SERVICES(29.2%)
g DATA NOT DISCLOSED; ASSUMED TO BE ZERO

SOURCES: U.S. BUREAU OF THE CENSUS, 1977 CENSUS OF SERVICE INDUSTRIES, MASSACHUSETTS;
COUNTY BUSINESS PATTERNS, 1977, MASSACHUSETTS

Table 9: PROJECTED IMPACT OF THE COMMUNICATION-INFORMATION-KNOWLEDGE INDUSTRIES ON BOSTON (1990)

I. Office Space Demand (1979-90)	Millions of Sq. Ft.
Direct Effect	
+ 39,475 Jobs in Communications and C-I-K Service Industries[1] at 240 sq. ft. per Worker	+ 9.5
Indirect Effect	
Additional Demand Created for Office Space in Boston by Growth in C-I-K Industries in the Metro Area (Equal to 10% of C-I-K Job Increase in Metro Area)	
+ 20,950 at 240 sq. ft. per Worker	+ 5.0
Total Direct and Indirect Effect	+14.5
II. Industrial Space Demand (1979-90)	Millions of Sq. Ft.
+ 2,438 Jobs in C-I-K Equipment Industries	
+ 3,508 Jobs in Printing and Publishing	
Total +5,946 Jobs at 400 sq. ft. per Worker	+ 2.4
III. Hotel Room Demand (1979-90)	Number of Hotel Rooms
+ 106,748 Workers in Boston, and	
+ 52,377 Metro Area Workers (one-fourth of increment)	
Total 159,125 x 5 Overnight Hotel Room Sales per Worker	
= 795,625 Room Sales	
= 1,136,607 Room Nights at 70% Occupancy	
= + 3,114 Hotel Rooms in Boston	+ 3,000
IV. Property Tax Yield (1990)	Millions of Dollars
+ 49,331 Boston Jobs (excluding increments in Education, Health, and Government) at $75,000 Development Cost per Worker and 2.5 percent property tax	+ $92.5

[1] Excludes job growth in Printing & Publishing, Education, Amusement and Recreation, Health, Hotels and Government.

Sources: Employment Projections--Appendix Table 1
Hotel Room Demand per Worker--see Boston Redevelopment Authority, Hotel and Convention Center Demand and Supply in Boston--Past, Present and Future, March 1979.

Table 10: VALUE OF SALES, 1982, AND FIVE-YEAR OUTLOOK FOR SELECTED INDUSTRIES IN THE COMMUNICATIONS-INFORMATION-KNOWLEDGE FIELD IN THE UNITED STATES

	Standard Industrial Classification	Value of Shipments, 1982 Estimated (Millions of 1972 Dollars)	Projected 5-Year 1981-86 Annual Growth Rate (Dollars of Constant Value)
Printing & Publishing	27	$39,169	3%
Computing Equipment	3573	33,600*	15%
Computer Services	737	18,000*	
Telephone & Telegraph Equipment	3661	8,190	5%
Electronic Equipment & Components			
Radio & Television Comm. Eqpt.	3662	18,500	10%
Electronic Components	367	23,909	
Instruments for Measurement,	3811		4%
Analysis, and	3822-4-9		3%
Control	3825,3832	11,305	4%
Photographic Eqpt. & Supplies	3861	10,250	6.5%
Broadcasting			
Radio	4832	4,135	12%
Television	4833	11,090	13%
Cable	4899	2,488	30%
Telephone & Telegraph Services	4811,4821	63,150	7%
Commercial Banking	602	1,039**	
Advertising	731	68,500	
Architectural & Engineering Services	891	35,489	
Educational Services	82	140,900***	1%
Hotels & Motels	701	28,084	10%
Motion Pictures	783	3,800	7%

* 1981.
** Billions of dollars of loans.
*** Estimated.

Source: U.S. Department of Commerce, Bureau of Industrial Economics, 1982 U.S. Industrial Outlook for 200 Industries with Projections for 1986. January 1982

Table 11: SAMPLE SURVEY OF BOSTON OFFICE INDUSTRY EMPLOYMENT, 1977-1978; COMPARISON OF TOTAL AND C-I-K RELATED SHARES

SIC Code	Industry	Number of Firms	Employment		
			Boston Area	Boston City	Survey Location
7	Mining	1	11	11	11
15	General Bldg Construction	1	8	8	8
16	Heavy Construction Contr.	2	53	53	53
17	Spec. Trade Contr. Const.	1	15	15	15
23	Apparel & Textiles *	2	22	22	22
27	Printing & Publishing *	18	253	203	203
31	Leather & Related	1	12	12	12
36	Electric Equipment	1	9,140	40	40
39	Miscellaneous Manufacturing	2	89	89	67
40	Railroad Transportation	3	12	12	12
41	Local Passenger Transit	1	20	20	20
47	Transportation Services *	9	110	110	66
48	Communications *	5	2,920	2,920	2,867
49	Utility Services	1	1,416	1,135	315
50	Wholesale Trade-Durable	19	602	597	127
51	Wholesale Trade-Non-Durable *	3	8	8	8
58,59	Miscellaneous Retail *	10	93	64	64
60	Banking *	4	250	242	242
61	Credit *	6	119	119	99
62	Brokerage *	40	1,931	1,931	1,710
63	Insurance Carriers	17	9,513	8,309	1,951
64	Insurance Brokers	33	3,275	3,264	464
65	Real Estate	19	417	395	391
67	Holding/Investments *	9	432	197	197
70	Hotels/Lodging *	2	17	17	17
72	Personal Services *	1	1	1	1
73	Business Services *	64	1,072	1,029	1,024
75	Auto Repair/Garages	1	2	2	2
76	Miscellaneous Repair *	2	4	4	4
78	Motion Pictures *	2	21	21	21
79	Amusement/Recreation *	9	79	79	39
80	Health Services *	12	405	405	105
81	Legal Services *	52	1,255	1,244	1,234
82	Education *	9	50	50	50
83	Social Services	14	162	156	110
86	Membership Organizations *	26	260	236	236
89	Misc. Professional Services **	75	1,620	1,599	1,546
90	Government	15	1,177	1,175	1,126
	Total	492	36,846	25,794	14,479
	C-I-K Total	313	10,379	10,217	9,543
	(C-I-K/Total) %	63.7%	28.2%	39.6%	65.9%

* C-I-K industry.

** ¼ C-I-K.

Source: Boston Redevelopment Authority, Michael Matrullo, The Office Industry Survey, Part II, An Analysis of Office Tenant Responses, March 1979, Sample Survey Information.

Table 12: ROLE OF COMMUNICATIONS-INFORMATION-KNOWLEDGE INDUSTRY FIRMS AMONG THOSE OCCUPYING OFFICE SPACE IN BOSTON, 1977-78

I. Summary of Sample of Firms Surveyed

SIC Code		A. C-I-K Industry Firms and Employment Firms	Employment
27	Printing & Publishing	18	203
48	Communications	5	2,867
481	Telephone & Telegraph	2	2,795
483	Radio & Television	2	77
489	Cable TV	1	5
59	Miscellaneous Retail	10	64
596	Closed Circuit TV Distrib.	1	1
591-5	Other	9	63
60	Banking	4	242
61	Credit	6	99
62	Brokerage	40	1,710
70	Hotels & Lodging	2	17
73	Business Services	64	1,024
731	Advertising	33	485
736	Employment Agencies	21	150
737	Data Processing	1	3
734, 739	Miscellaneous Services	9	141
78	Motion Pictures	2	21
79	Amusement/Recreation	9	39
80	Health Services	12	105
81	Legal Services	52	1,234
82	Education	9	50
89	Professional Services	75	1,546
899	Consultants	9	77
891	Engineering	31	1,227
891	Architecture, Planning, Design	24	200
892	Accounting	12	52
90	Government	4	282
Total C-I-K		313	9,543
		B. Non-C-I-K Firms Surveyed	
Total Non-C-I-K		178	4,936
		C. Total-All Firms Surveyed	
Total		492	14,479
C-I-K as a Percent of Total		63.7%	65.9%

II. Universe Estimate of Employment and Firms in Boston's Office Structures, 1977-78

	Firms	Employment
Total	5,020	147,238

Source: See Table 11.

COMMENTS ON PROSPECTS, INTER-RELATIONSHIPS, AND INNOVATION FOR SELECTED COMMUNICATION-INFORMATION-KNOWLEDGE INDUSTRIES AS REPORTED IN THE U.S. INDUSTRIAL OUTLOOK 1982*

* U.S. Department of Commerce, Bureau of Industrial Economics, 1982 Industrial Outlook for 200 Industries with Projections for 1986.

Investment

The top eight U.S. computer firms spent $3.5 billion on plant and equipment in 1980, a 36 percent increase over the previous year. A high proportion of these expenditures paid for the expansion of internal semiconductor production capacity and of computer manufacturing facilities. Funds went also for plant automation, reflecting the concern of many of these firms over the impact on profitability of rising labor costs.

Total research and development (R&D) expenditures of a sample of 20 major computer equipment manufacturers rose 19 percent in 1980 to $3.4 billion. This stood well above the 16.4 percent increase for all manufacturing reported in *Business Week's* annual survey of corporate R&D expenditures. The computer industry exceeded the composite for all manufacturing in two other R&D measures; expenditures per employee in the sample were twice as large as in the composite ($3,979 versus $1,834) while expenditures as a percent of sales were three times greater (6.4 percent versus 2.0 percent). It also outperformed the composites for the aerospace, electronics, semiconductor, and telecommunications industries in these measures, although these high technology industries showed larger annual percentage increases in R&D spending.

Most of these computer firms are currently engaged in R&D projects such as the application of laser and fiber optics technologies to communications links between computer equipment, the examination of new circuit technologies, e.g., Josephson junctions, and the possible replacement of silicon by gallium arsenide to improve the performance of future computer equipment. Software development has also received major funding.

Personal Computers

Personal computer sales gained strength during 1981, stimulated by strong demand in the business and professional user sectors and by the entry into the market of major U.S. computer and business equipment firms. It is estimated that 800,000 units in the under $10,000 price range were sold worldwide, with a total value of $1.6 billion in current dollars. The U.S. market represented about 75 percent of these sales in both units and value. Europe and Japan accounted for the remainder.

A number of manufacturers and retailers attempted to boost sales through price cuts of up to 40 percent on older models and through volume discounts on new systems. However, the leading U.S. firms concentrated on expanding their distribution channels to include dealers in office products and industrial equipment and mass merchanisers. They also continued to open company-owned retail outlets in the United States and overseas.

The availability of a wider range of software packages has helped to increase demand for personal computers among business and educational users. According to one estimate, retail sales of software marketed by manufacturers and independent software houses reached nearly $200 million (current dollars) in 1981, double the previous year's level.

Japanese manufacturers of personal computers began t challenge to the overseas leadership of U.S. firms by winn an estimated 75 percent share of their own domestic ma during 1980. Their success reportedly stems from their p ing strategies and the inability of their U.S. competitors produce enough units to meet the rapid expansion in Japan demand. These Japanese firms are expected to retain a ma ity share of their home market, even though the two lead U.S. companies have expanded their manufacturing and m keting operations in Japan and elsewhere in the Far East (ing 1981.

Japanese penetration of the U.S. market has moved m slowly than anticipated, with only a few major Japanese fi selling equipment here through mid-1981. This cautious proach reflects the current Japanese lag in developing a w range of applications software and in establishing competi distribution and service channels. Japanese personal compu exports to the United States in Japan's fiscal year ending Ma 31, 1982, are expected to reach 30,000 units valued at m than $40 million. Most of these exports compete in the low priced end of the U.S. market, following the pattern set by Japanese in other electronics products such as calculat radios and television sets.

Foreign Trade

Exports of computer equipment and parts rose 23.3 per in 1981 to an estimated $8.8 billion in current dollars. L more than half the previous year's growth rate, this incr reflected the adverse effects on U.S. computer exports of strength of the U.S. dollar abroad and downturns in key W ern European markets. The value of exports to many of th countries showed a shift toward a greater percentage of p over equipment. Ireland and Hong Kong have rece emerged as important importers of U.S. computers due marily to the buildup in these countries of U.S. assembly cilities, particularly those established by several leading mini- and microcomputer firms.

Imports of computing equipment and parts grew rapidly 1981, rising an estimated 38 percent to $1.6 billion. As a res the import-to-new-supply ratio increased from 0.045 to 0.0 Canada and Japan remained the leading suppliers with s stantial growth in both equipment and parts. In the case Japanese exports to the United States, joint marketing ventu between Japanese suppliers and U.S. distributors helped boost the 1981 level.

Imports from the United Kingdom and France fell 30 p cent below their 1981 levels with sharp reductions in the equ ment area. Parts assumed a larger share of imports from ma European countries and represented more than 90 percent import value from Hong Kong and Mexico. U.S. subsidiar based in many of these countries were significant contribut to these shipments.

Technological Developments

In 1981, a number of computer firms conducted tests on samples of 64K RAMs (random access memory integrated circuits with data capacities of 64,000 binary digits or bits) obtained from semiconductor suppliers. Various technical problems encountered by the semiconductor firms during development and production start-up (see Chapter 26) delayed the replacement of the older 16K RAM technology by these higher capacity circuits. High volume production and thus widespread use of these RAMs in computer equipment is now expected in the 1982–83 period.

The word length of a given computer is one measure by which to judge its processing capability. The first microprocessors in 1971 could manipulate 4-bit words, adequate for use in electronic calculators. Ten years later, in 1981, a U.S. semiconductor firm announced the first 32-bit word length microprocessor, dubbed the "micro-mainframe," since its word length equaled that of a large-scale computer. As these products have evolved, computer makers have incorporated them into their equipment. For example, personal computers which use 16-bit microprocessors are now appearing, offering increased processing capabilities over their 8-bit predecessors. Eventually manufacturers will market 32-bit desktop computers, which, when coupled with high capacity semiconductor and magnetic memories and with sophisticated software, will challenge the power of the large-scale computers of the 1970's.

Computer Networks

The interdependence of computers and communications has steadily grown, spurred by an emerging array of equipment and software products from various suppliers. As the interconnection of dispersed computer equipment via telecommunications links spread, the problem of the lack of compatibility between many of these products became awkward and expensive for both suppliers and users. For example, at one time a leading computer company sold several hundred different types of data communications equipment. To accommodate this equipment, the company furnished over 30 distinct software programs and more than a dozen separate protocols, i.e., the sets of rules governing communications between components of the system.

As a result, beginning in the mid-1970's, a number of suppliers announced computer network architectures, which standardized the physical and logical relationships between network components such as display terminals and central processors. Although this helped to ease the compatibility problem for a given supplier's products, the problem remained for systems employing two or more suppliers' equipment.

About the same time, standards organizations in Europe began to establish standards for public data networks, i.e., networks designed for computer communications and managed by countries' telephone authorities. The CCITT (The International Telephone and Telegraph Consultative Committee) based in Geneva led one such effort which resulted in the "X" series of standards, including X.25 (for packet switched data networks). Telephone authorities in many European countries, Canada and Japan, and several valued-added carriers in the United States have implemented this standard.

Although suppliers have maintained and improved their individual network architectures, many have also begun to offer software and hardware adapters linking their products to the more widely implemented data communications standards, such as X.25. While there remain problems of network interconnection, standards organizations—through continuing efforts to formulate broadly acceptable data communications standards—seek ultimately to attain network compatibility worldwide. The "Reference Model for Open Systems Interconnection" by the International Standards Organization (ISO) constitutes one such effort.

Local area networks, i.e., communications networks linking computer and electronic office equipment within an office building or campus, have exhibited high levels of innovation. These networks typically differ from their long-distance analogs in having higher data transfer rates, lower error rates and lower implementation costs. Computer suppliers have announced local area network architectures and systems which have become key concepts for the electronic office-of-the-future.

Computer Services

The computer services industry (SIC 737), a dynamic partner of the computer equipment industry, has three major sectors—processing services (including remote processing via telecommunications links), professional services (including training and consulting), and software products (packaged and custom programs).

According to a study conducted for the Association of Data Processing Service Organizations (ADAPSO), worldwide computer services revenues of U.S. firms rose 21 percent during 1980 to $14.9 billion. Software products and professional services grew faster than processing services with increases of 30 percent and 25 percent, respectively. These substantial growth rates reflect the tremendous demand for software and training brought on by expanded computer usage and the rapidly changing technological environment. The study stated the U.S. industry had over 4,300 companies in 1980, many of which had annual revenues of less than $10 million.

According to data compiled by the Bureau of Labor Statistics, total U.S. employment in this industry increased 12 percent through mid-1981 to 343,000 workers. Non-supervisory employees, such as programmers and analysts, represented 83 percent of this labor force and their numbers grew at approximately the same rate as total employment. Revenues for the industry were estimated to have grown by about 20 percent to $18 billion in current dollars during 1981.

Advancing Technology

New technology and competition continue to exert pressures for restructuring of the telecommunications industry. Satellite and data communications, mobile radio, and lightwave systems are being integrated into the conventional voice network. Today the U.S. telephone network incorporates both analog and digital equipment. Analog systems convert information into electrical tones which are amplified to maintain a specified transmission level. In digital transmission, information is broken down into on-off pulses which can be regenerated instead of amplified, eliminating any noise or interference that may have entered the system. The No. 4 ESS (Electronic Switching System), the new local No. 5 ESS, the T-carrier transmission systems, and the lightwave communication systems all operate in a digital mode. By 1990, the industry plans to convert to digital form 90 percent of all local and 40 percent of long distance transmission links. Conversion from analog to digital switching (both local and long distance) is also scheduled to be 90 percent completed during the 1980's.

Evolution toward the Integrated Services Digital Network is progressing at a rapid rate. Such a network will transmit voice, data, graphics, and images in digital form more cheaply and accurately than in the traditional analog mode.

Local data networks, utilizing a coaxial cable loop, are one means of interconnecting the various office terminals, including telephones; a private branch exchange (PBX) is another. Although no digital electronic PBX capable of handling data, voice, and video simultaneously is yet in operation in the network, "office of the future" digital PBXs are expected to be market tested by 1983. Digital PBXs will probably be the main switch to integrate the local loops and other intra-office systems and terminals. Shipments of digital PBXs by all manufacturers are expected to exceed 4,000 units in 1982.

Satellite communications demand continues to grow. The Federal Communications Commission (FCC) has approved the construction of 25 new domestic satellites and the launching of 20 new or already-built spacecraft. This authorization more than triples the current capacity of the existing satellite companies. In addition to the five existing domestic satellite companies, the FCC has authorized three other domestic satellite companies, each of which plans to operate and own its own system. The growth of satellite communications provides a large and growing potential market for manufacturers of earth station equipment and satellites. From an estimated $35 million in 1967, U.S. production of communication satellites reached $300 million in 1980 and is expected to grow to over $600 million in current dollars during the 1980's. The sales of earth stations are estimated to increase from $500 million to over $2 billion (current dollars) by 1990.

After years of testing, the FCC has given the go-ahead for the cellular-mobile radio system. This system, scheduled for introduction in 1983, will be available in 35 densely populated areas covering some 70 large cities within 3 to 5 years. Sales of mobile radio equipment—radio telephones and pagers—are expected to exceed $2 billion (current dollars) annually by 1990.

Lightwave systems are becoming cost competitive other transmission systems—coaxial cable, microwave satellite. The telephone industry is the major user of optic cables, which have the capacity for carrying up 80,000 simultaneous telephone calls. Sales of the fiber cable to the operating companies are expected to reach alr $350 million in current dollars by 1986.

The addition of the above categories associated with communications—lightwave systems, mobile radio, data c munications and satellite communications—to the telepl and telegragh equipment industry (SIC 3661) represents n closely the emerging computer-communications industry. aggregate was growing at more than 15 percent annu adjusted for inflation.

Research and Development

The telephone industry spent almost $1.6 billion in for research and development programs, producing a range of improvements in digital technology, microelectro lightwave communications and software.

New digital microprocessors can process 32 bits of info tion simultaneously, twice the capability of devices curr being produced. Containing 100,000 transistors, these processors should have widespread applications in many services provided by the telephone network.

Another promising development is the digital signal pr sor that can perform more than a million calculations a se This chip has been useful in research systems that synth and recognize human speech. It probably will also find u the new digital switching and transmission systems.

Recently developed digital microwave radio systems expected to be less expensive to manufacture than the exi predominantly analog radio systems. A new digital earp that converts a stream of digital pulses directly into a signal has also been developed. Both of these breakthro will be utilized in the all-digital telephone network.

Lightwave systems with greater capacity and versa and lower costs will continue the widespread applicatio glass-fiber cable to all parts of the telephone network. tinuing research has produced improved materials and sys capable of transmitting greater amounts of information longer distances without costly intermediate repeaters. F cables, no longer limited to interoffice trunking, have pote use in all portions of the network. Replacement of s microwave systems will occur and customer loop applica will begin. These cables are already being manufactured use in the long-distance network replacing the larger, costly coaxial cables.

Other growth markets that will increase the use of op fibers include: videotex, local data networks, satellite d bution, fiber optic sensors, robotics, the "office of the fut and the "factory of the future." As a result, some indu forecasts predict that annual worldwide sales of lightw equipment will reach close to $2 billion in current dollar 1985.

In the nationwide network, software directs the operation of over 3,000 electronic switching systems. Other software programs control data sets, PBXs and key systems. Bell Telephone Laboratories will build a new facility in 1982, housing 2,500 employees, devoted to the development of computer software and other systems required for "information-age" communications services.

Electronic Switching

At the end of 1981, more than 3,700 electronic switching systems (both analog and digital) were in operation serving more than 34 percent of telephone subscribers. These programmable machines provide a variety of revenue-producing features—such as speed calling, call waiting, call forwarding, and conferencing—without any additional equipment investment. Installation of electronic switching offices will continue at a rapid rate, reaching over 3,900 switches serving over 50 percent of the subscribers by the end of 1982. During the 1980's most of the electronic switches installed will be digital as the cost of the hardware declines at a rapid rate.

AT&T and the largest independent telephone company—GTE—have joined existing digital manufacturers in production of local switching. These new suppliers will expedite the conversion to the Integrated Services Digital Network (ISDN), which began in 1976 with the toll switches.

Most of the developed countries also have programs to convert their telephone networks to digital switching. U.S. firms are selling large digital switches in overseas markets; they will also have an opportunity to export smaller local digital switches as the Eureopean and the Japanese markets expand.

Since 1968, with the Carterfone decision that permitted the connection of customer-owned equipment to the telephone network, there has been a gradual move toward greater competition and deregulation. In 1971, the Specialized Common Carrier decision permitted companies offering new and innovative services to enter the long-distance market. In 1972, the FCC instituted an "open skies policy," which allowed companies with the necessary capital and expertise to own and operate satellite-assisted communication systems.

In 1980, the FCC went a step further, ruling that private companies could participate in the sharing and reselling of telephone services. The revised Telecommunications Competition and Deregulation Act of 1981 (S898) includes provisions for even more deregulation of the telephone industry.

Outlook for 1982

The increase in industry shipments, adjusted for inflation, projected for 1982 is only 2.5 percent, less than the compound annual growth of 6.5 percent posted between 1972 and 1981. Major manufacturers report a decline in switching machine orders for 1982. Very probably this decline in orders results from decisions by the telephone operating companies to await lower interest rates before continuing the conversion to electronic switching.

Despite this drop in central office orders, companies expec an expansion in the demand for PBX systems to link th communications data processing and word processing func tions in offices. The 1982 PBX market of over $2 billion i expected to grow 15 to 17 percent annually over the nex several years. Sophisticated programmable key systems an data sets with diagnostic features are other major component which contribute to the demand for equipment. Another i the intelligent telephone, with a built-in microprocessor, whic can accept instructions to forward calls, sound a wakeup alarm, record messages, calculate the cost of long-distance calls, and provide automatic or abbreviated dialing.

The data sets, key systems, and carrier systems together with a wide array of sophisticated telephone sets will continue their steady growth within the telephone and telegraph equipment industry. Over 31 million telephones were shipped in 1981, compared to 28 million in 1980. However, the net increase in the number of telephones was approximately 4 percent. This year unit shipments are expected to reach over 34 million, which will make a net increase in stocks of approximately 5 percent over 1981.

Long-Term Prospects

Telephone and telegraph industry shipments are expected to exceed $10 billion in 1972 dollars in 1986. These shipments should increase at an average annual rate of 5 percent for the 5 years 1981–1986. After a slowdown in the rate of increase in 1982, 1983 should see a growth rate of more than 8 percent, provided high interest rates ease. Conversion of central offices and PBX's from electromechanical to digital electronic switching, attachment of local networks and data equipment terminals to the national network, and an expanding overseas market will all contribute to sustaining the industry's rate of growth.

Automation and simpler production techniques for manufacturing electronic switches and components will limit employment increases in the years ahead. The forecast through 1986 is for no significant growth in employment.

Many countries participate in the world market. To encourage increased international trade, momentum is building toward mutual reciprocity between trading partners. Under this concept, the telephone authorities in many of these countries would open sales of customer equipment to both domestic and foreign suppliers. For example, the British and Canadian governments recently took steps to open their customer equipment markets to foreign competition. Sales of this interconnect equipment may eventually provide the avenue for direct sales to the postal, telegraph, and telephone authorities overseas.

In 1980, Japan and the United States signed a 3-year bilateral agreement to permit U.S. suppliers to compete with Japanese makers and other foreign companies in the supply of equipment to Nippon Telegraph and Telephone.—*William J. Sullivan, Science and Electronics Division.*

INSTRUMENTS FOR MEASUREMENT, ANALYSIS AND CONTROL

Instrumentation industries were among the first to incorporate electronic devices in products to expand functional capabilities. As technological progress enhanced the economic return on investment in instrumentation products, users often found that industrial instrumentation purchases paid for themselves within two years through decreases in energy consumption and resource waste or increases in product output. This trend is likely to continue as improved electronic technology is incorporated into instruments, aiding U.S. industry in its efforts to improve quality and efficiency.

The increased level and breadth of technology in measurement, analysis and control has resulted in a high degree of specialization of instrumentation firms. Since the instrumentation industries tend to be labor-intensive, entry barriers are minimal. Small firms which have the technological expertise and a minimum amount of capital can enter the market quite easily. Often a small entrepreneurship will produce a specialized product which fills a void left by larger companies because of the initially small market potential for the product. As the market develops, other firms begin to supply the product. This scenario has resulted in the diffusion of suppliers and in a decrease in the levels of industry concentration for most of the instrumentation industries. These decreases in concentration seems to be directly related to the growth rates of the several industries, as shown in the chart below.

Investment activity in the U.S. economy is another important factor affecting the instrumentation industries. Shipments of instruments tend to follow the trend of new plant

Industrial process control instruments (SIC 3823) represent the largest sector of the measuring and controlling instruments group of industries. Current dollar shipments in 1981 reached $3.4 billion, an increase of 10.9 percent over 1980.

Another type of instrument which shows strong growth potential is the logic analyzer used to inspect computer hardware and software for logical integrity and performance characteristics. The expanding requirements for computer software—which instruct computers what to do and how to do it —combined with the difficulties in obtaining software development services economically, should lead to the increased use of logic analyzers.

Expanding communication networks of all types are th impetus for increasing sales of data communications te equipment. As the number of input and output devices requi ing the ability to "talk" with one another grows, the numbe of possible communication links between devices grows eve faster. Adding to the challenge is the wide variation in types o equipment in use, often produced by different manufacturer Equipment for testing data communication devices is use for checking the validity of data transmitted between thes different machines. The growth in demand for data com munications test equipment should parallel growth in th telecommunications industries which is expected to be stron through the entire decade.

The continuing introduction of new electronic devices en sures a growing market for semiconductor test equipmen This equipment, which often automatically tests semiconduc tor components as they come off the production line, is con stantly being challenged by the increasing density of inte grated circuits. This creates more circuitry to test per elec tronic device; thus the semiconductor manufacturer has choice of either increasing the time allotted to test the de vice, or purchasing more sophisticated test equipment. Ofte the latter option is chosen, which led to large shipment gain during the halcyon years of semiconductor manufacturing. Th recent slowdown in semiconductor growth retarded shipment for this equipment during 1981.

Both th changes in the tax laws enacted last year and the propose increase in spending for military purposes promise short- an long-term benefits for most firms within this industry. Prov sions within the tax package now allow businesses not onl to deduct the costs of research and development, but also t take a 25 percent tax credit on the increase in R&D spendin over the average for the previous three years. Also, researc conducted by universities for business qualifies for this credi These provisions, as well as a general acceptance of the nee to revitalize the technological base of U.S. industry throug increases in R&D spending, should offset reduced Federal ex penditures for R&D, enabling analytical instruments to resum a high level of growth.

Other factors, including the increasing use of lasers whic require precision optical components and the increase in mil tary spending, also support the projection for strong shipment growth within this area.

crographics

Micrographic technology has been used for more than 50 rs to reduce storage requirements for documents. A iety of microforms, such as microfilm cartridges and setts, microfiche, aperture cards, and jackets, are available. mputer output microfilm (COM), developed during the 1950's, allows computer output to be directly recorded o microforms. Computer-assisted retrieval (CAR) systems nbine the speed and accuracy of electronic indexing with high volume data-storage capabilities of microforms. ntinued integration with data processing should allow crographics to compete for an active role in the "office of future." Product shipments of microfilm equipment were imated to have reached $520 million during 1981.

otocopying

Traditionally, the chief function of a copier has been to roduce an original document by a photographic copying ocess. Since the mid-1970's, however, computer and office uipment manufacturers have gradually introduced high-ed, nonimpact printers that combine printing and copying nctions. Industry sources generally refer to these machines "intelligent copier/printers" (ICP'S). The ICP has a mber of capabilities not present in traditional copiers, cluding: acceptance of information in printed or electronic rm; communication with other office machines over tele-mmunications networks; and the printing of copies in a iety of fonts and formats. As manufacturers develop this hnology further, the ICP should emerge as a key com-nent in the "office of the future," combining many pre-usly distinct functions: word and data processing, elec-nic mail, as well as printing and copying.

Manufacturers are offering more sophisticated convenience piers by adding features once available only on larger chines. Such features include automatic document feeding, llation, reduction, stapling and two-sided copying, all of ich should help keep demand for small plain paper copiers ong.

As the low end of the copier market expands, competition ong the new entrants and established firms will increase. substantial number of machines at the low end originate Japan. The United States, Japan's largest foreign market photocopiers, imported more than 40 percent of Japan's 80 exports. U.S. imports of photocopying machines in-eased more than 50 percent during 1980. The rapid growth te should continue; estimates place 1981 imports at about 0,000 units.

Through 1983, a major Japanese manufacturer of low-end otocopying machines will phase out distribution through its reign distributors—including one in the United States—and ll market its equipment directly. As a result, the affected S. firm has developed and will manufacture its own con-nience copier. Other U.S. firms have developed new market-g techniques and introduced additional low-end models in effort to stay competitive with Japanese manufacturers.

Long-Term Prospects

Manufacturers will continue to incorporate electronic components into photographic products, to automate manual functions, and to simplify usage. The development of new technologies, as well as continued product innovation in both the consumer and business segments, should stimulate industry growth during the 1980's. Industry shipments should increase at a compound rate of 6.5 percent a year through 1986, after adjusting for inflation.—*Joyce V. Watson, Science and Electronics Division.*

BROADCASTING
RADIO, TELEVISION AND CABLE TV

After years of modest influence in radio broadcasting, national networks have begun to play a more important role. Their number increased to 12 in 1981, with more in the planning stage. This growth results from several factors evolving at the same time: rising station personnel costs; the station's need for quality national and international news and information programs and for feature programing; and the availability of low cost wide band monophonic and stereophonic satellite audio channels for radio networking. The increasingly high cost of national television advertising and the ability of selected radio networks to deliver a specific demographic or ethnic audience for the advertiser's message are two other factors contributing to the growth of radio networks.

Long-Term Prospects

The outlook for radio broadcasting in the 1980's is for continued growth and change. Advertising expenditures for radio are projected to rise at a 12 percent compound annual rate to $7.5 billion in 1986. The resulting net revenues for the industry will amount to an estimated $6.5 billion.

To maintain this growth during the 1980's, the industry will need to manage change in an environment of severe competition. Stations will strive to identify with their communities, and to sharpen their programing in order to target selected audiences. Profitable operation will demand effective cost control. The economies of satellite network programing, insofar as individual radio stations are concerned, will lead to the establishment of additional radio networks.

The year 1981 also saw developments in communications which will increase the competition for viewers confronting conventional television broadcasters. Cable television, premium pay cable services, broadcast subscription TV, and pay programing distributed by MDS (multiple distribution service) continued to enroll new subscribers and to provide an alternative to broadcast TV. Some 14 applications for direct broadcast satellite (DBS) service and 5,000 applications for low power television stations were filed with the FCC. When stations in these categories begin broadcasting, further inroads are expected in the viewing time devoted to conventional network programing.

Competition from Newer Media

Conventional television broadcasters will experience increasingly vigorous competition for viewers and revenues during the 1980's. The competitors will include: cable TV, multiple distribution service (MDS), direct broadcast satellites (DBS), video cassettes, and video discs. Low power television stations, which will begin operation in this decade, will also attract viewers from established stations and networks. However, cable television—which is projected to have 32.9 million subscribers in 1986, and as many as 47 million in 1990—will provide the most serious competition for broadcasting. This competition will be three-pronged since viewers, advertising, and programs can be diverted from broadcasting to cable.

At this stage, it is difficult to quantify the inroads wh cable and the other entertainment media will make on c ventional broadcasting. The networks have highly develo skills for programing for the mass audience. Also, the gro in the number of television homes will offset to some ex the loss in viewing time to cable and other competing me during this decade.

Having recognized the growth that the cable industry achieved, broadcasters are starting to enter the indus either through the acquisition of systems or through development of programing for cable. Both ABC and C entered the cable programing field in 1981. The FCC certain restrictions on the cross ownership of a TV stat and a cable system serving the same audience. It prese does not allow the ownership of cable systems by TV works, but waived this rule to allow CBS to acquire a sm cable system for experimental purposes.

Low power television stations will make some inroads i the audience and revenues of both established TV stati and cable systems. Because of the limited coverage a therefore, limited revenues of these stations, and beca there is no requirement that they originate programs, ma will be centrally programed by satellite in a manner simi to cable. In the aggregate, these low power stations co provide an attractive medium for advertisers.

The introduction of direct (to the home) broadcast sa lites starting about 1985 will further expand competition the viewing audience. Fourteen companies submitted ap cations to the FCC in 1981. These satellite broadcasts w be on super high frequency channels in the 12 gigahe band. Reception will require a small dish antenna and add electronic equipment to be used in addition to a conventio TV receiver. Applicants for licenses for this service incl both those who will provide full broadcast service and th who will furnish only common carrier facilities to in pendent program suppliers.

The use of direct broadcast satellites for high definition high resolution TV has also been proposed because the quired wider channels could be provided at these super h frequencies. The introduction of high definition large scr television may occur in the late 1980's. Several techniq requiring advanced equipment have been proposed for transmission and reception of the increased information involved. All would require special receivers in the home

The broadcast by TV stations of textual information w out interference to regular programing will increase dur the 1980's. Experimental transmissions in the United St began in 1980. Several different techniques for encod textual information and transmitting it without interfere to the television picture are under study. This broadcast se ice, known as teletext, is expected to provide broadcast with an additional source of advertising revenue.

Television broadcasting has proved itself an effective m medium for national and local advertisers. The highly de oped programing skills of the networks and individual lo stations will provide the strength to compete with the ne media and assure the continued growth of traditional bro casting.

Basic cable service began in small communities which had no local television stations and where reception from distant stations was poor or nonexistent. Later, cable service was introduced in suburban areas and a few cities where it added the programs of one or two distant stations to those available from the local stations. The higher cost of installing cable in large cities, coupled with the greater variety of local TV programs readily available, kept cable systems out of many urban markets.

Domestic communications satellites revolutionized the cable TV industry by making possible low cost distribution of programing to independent cable systems throughout the country. Cable program services such as Home Box Office, Showtime, The Movie Channel, Home Theater Network, and numerous others were established to provide premium programing. Toward the end of 1981 there were nearly 50 cable programing services on the satellites; of these, thirty-seven were video services ranging from a few hours a week to 24 hours a day.

The premium program service supplied by the cable programers provide a second or even third source of monthly revenue for cable systems, in addition to the basic subscription fee charged to all cable subscribers. The additional revenue potential from premium programing, combined with the appeal of this exclusive programing to urban viewers, is making it economically desirable for cable companies to wire the larger cities. A number of major municipal franchises were awarded in 1981. The competitive process for the award of cable franchises is now either under way or under study in most of the other unwired cities. The cycle from the initial study of requirements and terms for a franchise through the evaluation of competing offers to award of the franchise can take many months, particularly in larger communities. Consumer demand for a wider choice of programing than is available from conventional broadcast television, and especially for the premium entertainment available through pay cable, is now the driving force for growth and profitability in the industry.

The ability of cable TV to reach large audiences has not escaped the attention of the broadcasting networks and newspaper interests. ABC and CBS have both established cable programing organizations, and CBS has reentered the cable TV business on a limited scale. Newspaper publishers, such as the Times Mirror Company, the Newhouse Group, the Tribune Company, and the New York Times, have acquired cable systems whose subscribers number nearly 2 million.

Long-Term Prospects

Cable television will continue its penetration of TV households during the decade of the 1980's. By the end of 1986, basic cable subscribers are expected to number about 32.9 million for a 39 percent share of total TV homes, and to provide about $5 billion in basic cable revenues. An estimated 22 million of these basic subscribers will be paying an additional subscription fee for a second tier of premium program service, and adding revenues of $2.8 billion. By 1990, the number of basic cable subscribers could reach 47 million, and provide $8.5 billion in current dollars of revenues. Pay cable revenues could provide an additional $5.8 billion from 32 million premium subscribers in 1990.

Cable systems are highly capital intensive, and many systems are highly leveraged financially. Despite high interest rates, capital has been available for expansion. During the 1970's the sale price of operating cable systems was often about $300 per subscriber. However, during 1980–81, prices increased to a range of $600 to $1,000 per subscriber, reflecting the increased revenue potential from premium pay cable service. The attractiveness of cable for investors lies in its predictability, its quasi monopoly position as a municipally franchised operation, its potential for revenue growth from additional subscribers or increased rates, and its ability to add new services.

The large number of channels available on cable systems and the growing number of cable program services are placing increasing demands on the suppliers of programs. Motion pictures, supplemented by sports, have been the mainstay of pay cable but these sources are not inexhaustible. Program suppliers are looking for new sources of entertainment programing and other video fare. Producers of motion pictures and other entertainment forms will benefit from the added demand and competition for their products. The already high production costs of feature programing for TV—which at present are recovered through network, syndication, and overseas release—will be even more costly if intended primarily for cable. Cable program suppliers will also seek to increase the variety of special interest programing appealing to specific demographic or other groups.

At present the amount of advertising on cable is small. But as the cable audience increases during the 1980's, cable will become a significant advertising medium. It will begin to share video advertising expenditures which, heretofore, have gone exclusively to broadcasters.

News and Information by Cable

The involvement of publishers in this electronic medium will expand during the 1980's. Cable, with its multiplicity of channels, escapes the pressure felt by the broadcast networks to serve the mass audience. It is free to devote channels to the dissemination and retrieval of information. Newspaper and magazine publishers have already recognized this either by acquiring cable systems or by providing information services to cable systems.

The delivery of news and information and its access by the public can take several forms. The simplest is the direct sequential transmission of textual material over one or more conventional cable channels to a conventional television receiver. A second technique called teletext provides owners of decoder-equipped TV receivers with a choice of 60 to 100 periodically updated pages of information. Teletext information is transmitted without interference to the picture during conventional TV transmission, but is invisible without a decoder. A third method for the distribution of information provides two-way interaction between a special key board/key pad equipped TV receiver, which acts as a display device, and one or more computer data banks. The cable system can be the two-way channel to the computer or can be used in conjunction with a telephone line for two-way communication. In addition to its information function, two-way systems can provide financial and shopping services.

The conventional television networks have begun to enter the cable TV field, primarily as programers. They expect to capitalize on their programing strength and to expand their participation in cable during the 1980's. In the past, the FCC has not allowed networks to own cable systems, but this restriction could be relaxed during the 1980's. If so, the networks may be expected to take an equity position in the cable industry.

At present, the demand for satellite channels to distribute programs to cable systems exceeds the supply. Additional satellites will be placed in orbit during the next few years. Competition among program suppliers will be severe, and some shakeout will be inevitable.

The cable TV industry is already competing with conventional TV broadcasting for audience. It will also face competition during the 1980's from the multiple distribution service (MDS), which is presently providing microwave distribution of premium pay televising service to commercial subscribers and private homes, and from subscription television (STV) broadcast in scrambled form by conventional TV stations to descrambler-equipped receivers. Direct to the home broadcast satellites are expected to begin service by the mid-1980's, adding further competition for the cable TV industry.

These alternative means for the distribution of programing to the public are expected to coexist in the 1980's, with the marketplace determining their relative growth and financial success. However, cable TV with its large number of channels, its capability for two-way interactive communications, and its ability to provide public service and public access channels is expected to continue its strong growth during the decade ahead.—*E. MacDonald Nyhen, Science and Electronics Division.*

TELEPHONE AND TELEGRAPH SERVICES

Advancing technologies, especially improved satellite and ta communication systems and new digital electronic vitches, are providing more choices and improved services a variety of users. Digital techniques and microelectronics ve rejuvenated telecommunications, making available at wer costs a host of services and products such as: elec-onic shopping, banking and mail; security and energy-con-rvation systems; audio and video teleconferencing; and rtable telephones.

Increased deregulation of the industry will continue during e 1980s, fostering the growth of competition. The tradi-onal common carriers are restructuring internally to com-ete with the non-regulated computer and interconnect com-anies, specialized and value-added carriers, and the domestic tellite companies.

elephone Network Expansion

Traditional common carriers invested $23 billion in new lant and equipment in 1981, up 5 percent from 1980. Ap-roximately 55 percent of capital expenditures was to support rowth from new customers and to increase the capacity of e existing network. Modernization projects accounted for out 20 percent, including conversion to electronic switches, d installation of improved digital carrier systems. The mainder of the construction program covered the costs of stomers moving to new locations (19 percent), and the placement of old equipment (6 percent). The specialized rriers planned to invest more than $600 million for the pansion of their long-distance microwave networks.

Transmission facilities continued to expand in both capacity d speed. For example, in November 1980, the Federal ommunications Commission (FCC) approved a new long-istance lightwave system, which uses glass fibers to carry formation in the form of laser-generated light beams. Con-ruction will begin during 1982 and the schedule calls for mpletion in 1984. The system will span 776 miles between losely, Virginia, and Cambridge, Massachusetts, crossing ght states and the District of Columbia. This system, costing ore than $90 million, will use digital rather than analog chnology, and will connect 21 high-capacity electronic vitches (550,000 calls per hour) in the busy Northeast rridor. Future planning includes the extension of this ghtwave system from New York to Chicago, and from losely to Atlanta and Miami by the late 1980's.

Satellite communication facilities are expanding rapidly ee Chapter 25, Telephone and Telegraph Equipment). tellite Business Systems (SBS) for example, has invested most $600 million in a satellite communications system hich has two operating satellites in orbit.

Satellite Television Corporation, a subsidiary of Com-unications Satellite Corporation (COMSAT), announced ans to spend at least $683 million to begin the first direct oadcast satellite (DBS) service to the home, providing three y-television channels. The company promises an opera-nal system within 3 to 4 years after FCC approval.

Three other new market entrants, Southern Pacific Com munications, Hughes Aircraft Company, and General Tele-phone and Electronics' GTE Satellite, have received per-mission to own and operate their own systems. Each of these systems will require an initial investment of over $200 mil-lion. The existing domestic satellite companies, Radio Cor-poration of America's RCA Americom, Western Union's WESTAR, and American Satellite, are plar ing major ex-pansions. The American Telephone and Telegraph (AT&T) Telstar network, consisting of three 24 transponder units, plans to replace the existing COMSTAR system, leased from COMSAT, by the mid-1980's. The Telstar-3 project will cost about $300 million.

The FCC has proposed a rule that would narrow the space between communication satellites, and potentially double the number of orbital slots available over the United States. The proposed new rule would expand the limit to between 60 and 80 satellites.

The investment of hundreds of millions of dollars to expand existing systems and to establish new domestic satellite systems is stimulating growth of the associated earth station industry, both equipment and servicing.

Suppliers are expanding data communications networks. The Dataphone Digital Service (DDS) from AT&T, that provides most of the transmission links for U.S. packet switch-ing networks, reached 93 cities nationwide during 1981. The telephone companies are gradually converting the predom-inantly analog U.S. telephone network to a fully digital network, the Integrated Services Digital Network (ISDN), that will transmit all types of information (voice, data, fac-simile, and video signals) in digital form. Information in digital form can travel at higher speeds (64,000 bits per second versus 9,600 bits per second for analog), with less expense and greater accuracy. As part of this implementation, telephone companies are replacing analog with digital ex-change switches. Several manufacturers are now offering local area digital networks (LANS) which integrate com-munications within an office, or between neighboring build-ings. Digital Private Branch Exchanges (PBXs) should even-tually become primary links between these LANS and the ISDN.

In April 1981, the FCC approved digital termination sys-tems, which can bypass the local telephone company loop to the home or office. The FCC has allocated the microwave frequency from 10.55 to 10.68 gigahertz (billion cycles per second) for this local digital distribution. SBS, MCI and five other communication companies have submitted applications to provide this new service.

Firms from the computer industry offer data communi-cation products, such as data terminals, which have served to expand data services.

International Markets

International telephone calls increased more than 20 percent during 1980 to 449.8 million calls or messages from 372.3 million in 1979. The five international record carriers (IRCs), ITT Worldcom, RCA Globecom, TRT Telecommunications Corp., Western Union International, and FTC Communications Inc., reported revenue increases of almost 9 percent in 1980, with similar growth indicated for 1981. Deregulation in international telex traffic (FCC docket 19660) permitted the IRCs to expand their gateway offices. Overseas gateway offices are now authorized for 69 major cities. Pending legislation (S. 271 and H.R. 4927) proposes that each of the record carriers be authorized to provide record communications in both the domestic and international markets. In turn, the legislation permits Western Union, the sole provider of domestic telegraph, to serve overseas locations.

In the 1970's, international calling grew rapidly. Volume rose from 92 million messages in 1970 to 372.3 million in 1979. To meet continuing demand, international circuits increased to 19,064 at the end of 1980, about 20 percent more than at the end of 1979.

International Direct Distance Dialing (IDDD), by which users can dial a growing number of nations directly without operator assistance, has boosted overseas business significantly. International Direct Distance Dialing began in 1970 for calls to the United Kingdom, originating from New York City. By 1979 there were 64 locations around the world with IDDD capabilities. Ten more were added during 1980, and in February 1981 suppliers added another eight, for a total of 82. At the end of 1980, electronic central offices capable of providing automatic direct overseas calling served over 50 percent of U.S. telephone customers.

The Communications Satellite Corporation (COMSAT), representing the United States, provides international communications services through satellites owned by the International Satellite Organization (INTELSAT) in which 105 other countries participate. At the end of 1980, COMSAT was leasing 9,808 circuits to other U.S. international record carriers for telephone, message, data, and facsimile services, a 29 percent increase from year end 1979.

In addition to these communications services, COMSAT also provides satellite services for the transmission of television programs. As a result of a Federal Communications Commission (FCC) decision in 1979, users of international television services can, for the first time, obtain those services directly from COMSAT rather than indirectly through the international record carriers. COMSAT General, a subsidiary of COMSAT, controls four domestic COMSTAR satellites and has leased the circuits to AT&T and GTE for domestic services. The fourth and last satellite in this program was launched in February 1981. Each of these satellites can relay 18,000 simultaneous telephone calls or 24 channels of television programming. Leasing revenues from COMSTAR in 1980 amounted to $49 million. The program is expected to end in the mid-1980's when AT&T completes the establishment of its own domestic communications satellite system (Telstar-3).

INTELSAT expanded its worldwide network of earth stations in 1980 with the installation of 41 new earth stations and the addition of 56 antennas. By the end of 1980, there were 263 earth station sites (eight in the United States and its territorial possessions) and 325 antennas in 134 countries. INTELSAT's 12 satellites served 154 countries, territories and possessions and leased capacity to 15 nations for domestic services. This network leased a total of 20,305 circuits and carried 28,392 hours of television during 1980. The system now handles two-thirds of the world's international public telecommunications. Plans for 1981 included additional installations of 166 antennas and 135 earth stations.

INTELSAT launched the first of nine new INTELSAT V satellites in December 1980. Each of these satellites has a capacity of 12,000 simultaneous two-way telephone circuits, plus two television channels, which is double the capacity of the INTELSAT IV-A series. The remaining satellites are expected to be launched through 1984 aboard Atlas Centaur rockets, the Space Shuttle, and the European Space Agency's ARIANE launch vehicles. The next generation of satellites, the INTELSAT VI, will have a capacity of more than 37,000 simultaneous two-way telephone circuits. This new series is expected to begin operation in the mid-1980's and have an operational life of at least 6 years.

Videotex and Teletext

Two general types of electronic information systems, videotex and teletext for home and commercial use, are currently undergoing testing in various countries.

Videotex is a two-way interactive system which allows users to access information stored remotely in a computer data base and display it on their television sets or video monitors. Access to the computer base can be via telephone or cable TV lines, or in some special experiments, via fiber optic cable. Businesses are currently the principal users of videotex services, which include electronic mail and banking. At the present time three major videotex systems are competing in the world market: Prestel (United Kingdom), Telidon (Canada), and Teletel (France).

Teletext is normally a one-way system that provides information via the unused portion of a television broadcast channel. Subscribers can select information displayed sequentially on television sets by using a special decoder and keypad. Suppliers can make the system two-way by the addition of a telephone or cable link. Examples of major teletext systems in use are the Ceefax and Oracle (United Kingdom), and Antiope (France).

The development of both types of systems in Europe, Canada and Japan has occurred largely through the cooperative efforts of government agencies, particularly postal, telephone, and telegraph authorities (PTT's), and private enterprise. In contrast, in the United States, telephone companies, news publishers, cable television operators, and broadcasters are conducting trials of these systems with minimal government involvement and subsidies.

New Technology

The international operating center in Pittsburgh, Pennsylvania, which handles overseas calls between the United States and 74 foreign countries, changed from manual operation to a totally computerized system. The International Service Position System (ISPS) now serves 150 operator positions. Before ISPS, operators used special graphite pencils to fill out a card for each overseas call processed. A cathode ray tube (CRT), electronic keyboard, and computer data base have replaced the pencils, tickets, code books, and rate schedules. The new system removes the tedious aspects of the operator's job, reducing billing errors and increasing the productivity of the operator.

A remote-controlled, submarine vehicle is completing the burial of the newest transatlantic cable (TAT–6). This procedure protects undersea cable from fishing gear dragged along the bottom by trawlers. The craft, called SCARAB (submersible craft assisting repair and burial), uses high pressure water jets to bury cables aproximately 2 feet below the ocean floor. The 2½ ton unit is one of two developed by Bell Laboratories, the French Ministry of Posts, and British Telecom International. The vehicles, capable of operating at depths up to 1 mile, also can repair cables. After electronic sensors locate the damaged section of cable, water jets are used to unearth it. Mechanical arms cut the cable and attach

o raise it to the ship. Technicians observe the opera-
ith onboard video monitors.

advanced Time Assigned Speech Interpolation
) equipment used in three underseas cables between
ited States and France have doubled the circuit capac-
e process boosts capacity by sandwiching fragments of
conversations on the same circuit. At the originating
computers assign time slots to each fragment of con-
on and reassemble them into the correct conversation
eceiving end.

mates suggest that teleconferencing could replace about
all business meetings. Audio conferences could meet
eds of 20 percent of these meetings. Ten percent would
full motion video. The remaining 70 percent would
audio with graphics. Electronic blackboards, sophis-
conference rooms with picturephone meeting service,
gh speed facsimile machines, are examples of the kind
ipment developed for these electronic meetings. In
1981, AT&T filed an application with the FCC for
sion to construct and operate a 42-city network to be
eted by the end of 1983.

Long-Term Prospects

estic telephone and telegraph service revenues are
d to increase at an inflation-adjusted rate of 6 percent
1981 and 1986. International telephone services
grow by 19 percent annually during this same period.
es in 1986, measured in 1972 dollars, are projected at
lion for domestic telephone and telegraph services and
billion for international telephone and telegraph
. Combined revenue growth will be at a nearly 7
rate to reach $82 billion measured in 1972 dollars.
ajor reason for the growth in international services is
e with which people can place telephone calls to
relatives, and business associates overseas. Inter-
l calling experienced unprecedented volume growth
the 1970s. Current forecasts show that the number of
s circuits must quadruple by the end of the 1980s to
the anticipated growth in overseas calling. Residential
ne customers generate approximately half of all inter-
l traffic, with the remaining half coming from business

industry forecasts state that videotex and teletext
will grow to a multibillion dollar market by the late
For this growth to occur, several developments will
essary. The emergence of a mass consumer market
end on the success of information providers identify-
ices which home users will find attractive. Agreement
dards is another necessity. A unified approach to
standards was adopted by the European Conference
Telecommunications Administrations (CEPT) in June
In the United States, the Federal Communications
ssion is allowing the marketplace to develop a de
andard.

hopping, telebanking, and other two-way services will
popularity, placing greater demands on the trans-
links between the home and the computer. Hybrid
such as one-way video via broadband cable or satel-
works and return via narrow-band telephone lines will
y become the basis for home information systems.

Expanding Services

Service providers expect revenues from satellite communications to jump at rates of 20–30 percent over the 5-year period 1981 to 1986. Each generation of satellites has represented a substantial increase in information carrying capacity. Conversely, earth stations have become smaller and cheaper. The National Aeronautics and Space Administration (NASA) plans to launch a total of 16 satellites in 1981, covering military, domestic, and international uses. In contrast to earlier, lower-orbit communications satellites, current models travel in a geostationary orbit, 22,300 miles above the equator. In this orbit, satellites appear to remain stationery above a point on the earth, since the rotational velocity of the satellite equals that of the earth. As a result, systems can employ fixed earth station antennas, which are smaller and less expensive than previous tracking models. The first earth stations were 9 meters in diameter. The antennas for the new direct broadcasting system (DBS), which will feature satellite communications directly to the home, are less than 1 meter in diameter.

The cost of transporting satellites into earth orbit is also declining. The U.S. Space Shuttle will carry future satellites at a cost of only $6 million per satellite, compared to a per-unit cost of $23 million using Delta rockets.

Development of fiber-optic communications technology began in 1970. Laboratory and field tests in 1975 and 1976 confirmed the feasibility of using lightwave systems to transmit information over hair-thin glass fibers. The price of manufacturing the glass fibers has declined since then.

The cost of 1 meter of an optical fiber circuit has dropped from $2.50 in 1977 to $.60 in 1981. A further decline to only $.20 by 1985 appears probable. The unit costs of the lightwave components (solid state lasers, photodetectors, and optical repeaters) are also dropping as production expands.

If the current trend in declining costs for manufacturing optical fibers and opto-electronic components continues, lightwave systems could become economically competitive with satellites for long-distance communications, including transoceanic routes, by the 1990s. It is now possible for two strands of optical fibers, each thinner than a human hair, to carry 2,000 telephone calls. In the 1990's manufacturers expect to have fibers capable of carrying over 10,000 telephone calls.

Forecasts call for the telephone industry to spend $400 million annually by 1986 on lightwave systems. This compares with expenditures of $125 million in 1982.

A new lightwave underseas system is scheduled to go into operation during 1988. This new digital cable system, TAT–8, will be about half the diameter of its coaxial counterparts and will carry the equivalent of 36,000 voice circuits. That is more than all of the existing transatlantic cables combined. Because TAT–8 will be digital, television video teleconferencing, and wide-band data transmissions will be feasible via undersea cable for the first time. The cost of this new cable will be about $230 million.

After two successful test flights of the space shuttle, the United States has entered a new era in outer space. The shuttle can orbit payloads of over 32 tons, 16 times the capacity of current unmanned launch vehicles. The vehicle can also return approximately 16 tons of payload to earth. The shuttle will also be able to test new satellites in low earth orbit, and repair any malfunctions before launching them into geosynchrouous orbit. The other major application of being able to put large payloads in orbit is the ability to use the space environment, especially the application of microgravity to industrial processes. Four space-manufacturing areas seem especially promising: pharmaceuticals, electronic devices, glass products, and advanced alloys.

Services In International Trade

With U.S. merchandise trade in deficit throughout most of the 1970's, exports of services have assumed an increasingly important role in our balance of payments. During the 1980's, the service industries associated with telecommunications will become a significantly larger portion of international trade. Satellite, data, and security communication systems are expanding in the domestic market and should become a growing part of international trade. Computer services utilizing communications links (e.g., data base retrieval) currently contribute significantly to the surplus in the U.S. balance on goods and services.

In 1980, U.S. data processing firms, including software companies, had worldwide revenues of $14.9 billion. Industry estimtaes place U.S. exports of data processing services and software-packaged programs at $2.2 billion in 1980. Such exports are projected to reach $15 billion by 1990.

The demand for satellite communications will continue to grow during the 1980's. More than 500 new earth stations should commence operations each year, mostly in the developed countries. The operation of these earth stations will result in a multibillion dollar service industry. Satellite launching activities via the U.S. space shuttle and the European Ariane rocket system will also comprise another billion-dollar industry.

Telecommunications systems engineering services should proliferate in the 1980's as the less developed countries demand more sophisticated systems. Telephone companies will offer system engineering services, which often result in the award of equipment contracts. Computer security systems in the United States should grow from $150 million in 1982 to over $500 million by 1985. Worldwide, these security services should find lucrative markets as the need to protect sensitive data communications gains recognition.

Office of the Future

The urgent need to increase white-collar productivity has placed new emphasis on advanced office systems. Industry studies indicate that white-collar labor accounted for 77 percent of the total office cost in 1981 and that proportion is likely to edge higher over the next five years. Estimates show that currently only $3,000 in capital equipment supports the average office worker, compared to $35,000 for a factory worker and $50,000 for a farmer. Suppliers have responded by designing third generation digital electronic PBX systems, advanced packet switching networks, and local area data communication networks to improve substantially office communications. Telephone calls, mail, meetings, and paperwork consume a great deal of office workers' time. These activities are communications related and can be made more efficient by office automation.

New digital PBXs are capable of handling data and facsimile as well as voice. High speed data terminals and electronic word processors can be interconnected through a PBX. Electronic mail, automatic answering, voice message storing and forwarding and even energy conservation controls are standard features of these new systems. More information can be efficiently accessed and collated, less time is spent traveling and returning telephone calls (for every 10 completed calls, 20 to 36 total calls are needed), and paperwork can be either eliminated by visual displays or made more effective by dialing electronic work stations. A recent estimate reveals that over 30,000 businesses could utilize such features in their integrated office systems environment.

Local area networks connect multiple data work sta and computers within a building or complex via coaxial c These user-owned private networks facilitate communica flexibility and economy in internal data systems by provi easy interconnection.

The value-added networks originated in the 1970s. T systems provide digital transmission nationwide by lea digital transmission links from the common carriers to nect the central office computer nodes capable of storing forwarding data packets. The packets can be delivered specified address or destination in accordance with the pri assigned to the message. These packet switching netw are capable of handling a wide variety of different termi and can deliver electronic messages at an average cos approximately $4, including the cost of the message prep tion and the terminals device.

Western Union offers a type of electronic mail service conjunction with the Post Office, called Mailgram geare smaller businesses. The U.S. Postal Service has propo other electronic mail services—E-COM (Electronic C puter-Originated Mail) and INTELPOST (Internati Electronic Post). E-COM will allow volume mailers to tr mit their computer-generated messages via telecommun tions carriers to 25 serving post offices to electronic recei equipment supplied by the Radio Corporation of Ame (RCA). Messages transmitted electronically to the ser post office are delivered within two days. ITELPOST, w is now offered between the U.S., Canada, and Great Bri is a high speed, low-cost facsimile service.

The reduction of costs in check processing is closely related to the development of electronic funds transfer (EFT).

EFT Developments

The most widespread EFT developments in the seventies have been in automated teller machines, used on or off premises to perform several teller functions electronically; telephone bill payments; and automated clearing houses (ACH), a system for clearing interbank debits and credits in an electronically readable form. During the eighties, use of the ACH system is expected to expand. This might take the forms of direct deposit of payroll, a convenience to employees and a source of savings to employers; of preauthorized debits, authorization to a bank to debit an account for a specified amount on a certain date and credit another account: and of check truncation, the receipt of periodic computer-generated statements instead of cancelled checks.

A development that will have a strong impact on the electronic transfer of funds in the future is the point-of-sale (POS) system. This system transmits a message electronically from a terminal at a merchant's outlet to a depository institution. At present, most of the messages relate to check verification and guarantee, but the ultimate objective is to transfer funds from the customer's account to the merchant's. Of course, if more than one depository institution is involved in the transfer, then a central switch would be required to route the messages to the accounts affected. The Federal Reserve is considered the most likly candidate for tht operation of these switches, because it possesses the telecommunication facilities and computers necessary for the job.

EFT Issues

Some basic problems that will eventually affect the final structure of a nationwide EFT system have yet to be thrashed out:

Pricing: Because of high start-up costs and long payback periods, financial institutions have been reluctant to decide to implement an EFT system. For years, they have been underpricing checking account service because the Federal Reserve provides free check-clearing services, but this came to an end with the passage of the Monetary Control Act of 1980, which makes check clearing available to all depository institutions at a price. As a result, bank costs will go up, checking account activity will be explicitly priced and EFT services will become relatively more attractive.

Truncation: Check truncation is one EFT process that has probably produced an adverse reaction from bank customers. It eliminates a service they value, the returned endorsed check, which serves as a receipt and a record of payment. Perhaps if the savings atributable to truncation are passed on to the consumer, some acceptance might be forthcoming.

Float: Some people consider the loss of float as a result of immediate debiting of accounts also an obstacle to customer acceptance of EFT, But again, because the Monetary Control Act of 1980 allows the Federal Reserve to change for float, any advantages associated with the present payments system will disappear.

National Network: Who will operate the nationwide EFT network when it finally is established is still being debated. Although the Federal Reserve is eminently suited to process a large volume of transactions through the ACH network, a number of private EFT networks already in existence can be involved operationally.

Sharing of Systems: Terminal sharing, agreed to by the parties and consistent with antitrust laws, is a regulatory issue that has yet to be solved. Many states have passed legislation requiring sharing in some form but the U.S. Department of Justice has declared its opposition to mandated sharing on competitive grounds.

Interstate Banking Report

Under the International Banking Act of 1978, Congress mandated a study to explore the appropriateness of the restrictions on interstate banking. These restrictions relate mainly to the McFadden Act of 1927, which gave states the authority to set branching standards for banks within their jurisdictions, and to Section 3(d) of the Bank Holding Company Act of 1956, known as the Douglas Amendment, which prohibited multibank holding companies—and later on one-bank holding companies—from acquiring a bank in another state, unless the law of the state in which the bank to be acquired was domiciled affirmatively provided for such entry.

The study report, released in early 1981, concluded that the interests of bank customers and the financial system would be served much better by significant liberalization of existing geographic restrictions on the services the banking industry provides. To achieve this, the report suggests modifying both the McFadden Act and the Douglas Amendment, but it leans toward a phased liberalization of the latter as being less disruptive to financial institutions and the existing regulatory structure. For example, Congress could consider initially restricting interstate acquisitions by limiting the market areas banks might enter, or it could consider imposing limits on the percentage of local market shares that an out-of-state bank holding company could hold.

Another of the report's recommendations is to subject the deployment of EFT terminals to less onerous geographic restrictions than those imposed on brick-and-mortar branches. Initially, this deployment could be permitted on a statewide basis and within SMSA's that cross state lines; nationwide EFT deployment could be permitted at a later date. Such deployment would bring added convenience to the banking public and, given sufficient volume, EFT neworks would result in cost savings both to financial institutions and to their customers. Sharing of EFT networks among depository institutions would mitigate any tendency for geographic liberalization to benefit larger banks and to foster concentration of resources.

Competition for Financial Services

The changes expected in the financial services sector during the next few years will have a profound influence on the commercial banking industry. The passage in 1980 of the Depository Institutions Deregulation and Monetary Control Act was a major step towards homogenization of all depository financial institutions. The Act provides for phasing out all legally imposed deposit-rate ceilings and permits all depository institutions to engage in interest-bearing transactions. Further equalization of the powers of financial institutions and continued erosion of product distinctions will mold the United States financial system during the present decade.

Intensification of product differentiation has heightened even more than before the rivalry between commercial banks on the one hand and savings and loan associations, mutual savings banks, and credit unions on the other. But it is the extra-industry competition that will dominate financial markets in the future, as nondepository and even nonfinancial institutions provide an array of services completely substitutable for those banks and thrifts offer.

Nondepository institutions are free from the legal and regulatory burdens imposed on depository financial entities—free from deposit interest rate ceilings, reserve and capital requirements, and branching restrictions. They are at liberty to provide a great variety of services, including business financing, consumer and real estate lending, personal financial counseling, credit cards, payments systems, investment management, money market funds, foreign exchange transactions, and a plethora of other activities. One day, these institutions might become financial supermarkets or one-stop money shops.

Commercial banks, of course, are not standing idly by while the conglomeration of the financial services industry is taking place. Entrepreneurship is such that it is perennially in search of cracks in existing legislation and regulation. Although banks, for instance, cannot directly provide certain financial services, they are permitted to have affiliates that offer these services or can use roundabout methods to do so. Branching restrictions can be circumvented in some cases by establishing loan production offices or by bank holding companies operating subsidiary finance companies or mortgage banking companies. Technological developments, in the form of improved transportation, computer, and communications systems have also enabled banks to reach farther and farther for business.

Banks are also diversifying. They are getting increasingly involved in international trade because their customers are becoming more and more export oriented; they are forcefully marketing their equipment-leasing activities; and they are offering a large number of fee-based services, including tax preparation, accounting, data processing, economic research, and investment banking.

It is evident that in the long run the banking community will react to the challenge of competition with vigor and ingenuity. But in the short run, such factors as inflationary pressures, business investment, monetary growth rates, stability in the money and capital markets, and consumer confidence will affect the operations of U.S. financial institutions.—*Wray O. Candilis, Office of Consumer Goods and Service Industries.*

Future Prospects

It is expected that over the next five years theaters will face strong competition from pay cable television and, as a consequence, will probably be required to pay higher film rentals. This, in turn, will cause ticket prices to rise, reducing attendance and cutting into refreshment revenues upon which many exhibitors depend for a large part of their incomes.

The pay cable industry will probably be Hollywood's largest and most important customer sooner than had been expected; and the future revenue potential of pay television may be significantly greater than that of the movie theater industry. It is too early to determine what effect pay cable has had already upon the declining number of moviegoers, but it is anticipated that the effects in the future will be as great, if not greater, than when television was first introduced. The majority of analysts believe that the answer to pay television is the production of quality feature films that would gross enough boxoffice receipts to cover operating costs. Major studios insist that they want to keep the movie theater industry healthy because the revenues from a successful theatrical run are much higher than those from either network or cable television; also success of a film in a theater largely establishes the price other media will pay for it.

Long-Term Prospects

With the enactment in 1981 of the Federal tax relief program for corporations and individuals, the advertising industry foresees increased ad revenue in the years ahead. The tax program, designed to stimulate investment and production, should heighten business activity which, in turn, would invigorate sales promotion and thus benefit the advertising industry. Cable television advertising will also turn out to be a bonanza for the advertising industry because consumers will spend only a limited amount for commercial-free programming. Thus, subscriber resistance to commercials will weaken with the possibility of lowering the cost of pay television. However, cable advertising will probably not grow to any substantial degree until a larger percentage of the country is wired and more information is compiled on the demographics and viewing habits of cable's audiences.—*Theodore A. Nelson, Office of Consumer Goods and Service Industries.*

RECENT REPORTS OF THE PRE-EMINENCE OF SERVICES AND HIGH TECHNOLOGY IN BOSTON AND THE METRO AREA

Service industries prop up the old factory cities

Health care, education, finance, and trade are easing cyclical swings in business

One of the biggest surprises of the recession is that many urban centers in the old industrial heartland are suffering less than might be expected. The smokestack industries—autos, steel, machine tools—have been badly battered in this recession. But with the exception of Detroit and Pittsburgh, unemployment in the major metropolitan areas of the Northeast and Midwest is about the same as the national average, and in the case of Boston, New York, and Philadelphia, it is less. Moreover, unemployment in some of these cities is lower in this recession than in the 1974-75 downturn, when the slump was less severe.

The major reason for the improvement is that these cities have been moving away from traditional manufacturing and toward service industries, such as health care, education, finance, and trade, which are far less sensitive to the swings in the business cycle. Indeed, nearly all of the growth in employment in the old manufacturing cities has been in the service sector (chart). And most economists believe that, to revitalize, the old cities will have to attract more and more service industries.

new pattern. But such a transformation will take a long time, as the experience of Boston and New York shows. And it will require that business and government leaders accept a permanent loss of jobs in the traditional manufacturing sector, something that is often politically difficult for them to do. They will also have to provide good transportation, communications, and education to attract and keep service industries. This means avoiding heavy reliance on tax breaks or other incentives that waste revenue resources needed for investing in the infrastructure.

Boston and New York have set the pattern for transforming the economic base of aging industrial cities. Although manufacturing jobs in metropolitan Boston have been growing slowly since 1975, that improvement follows many years during which old-line manufacturing industries—especially shoes and textiles—gradually disappeared. In New York, manufacturing jobs have declined by 40% since 1965.

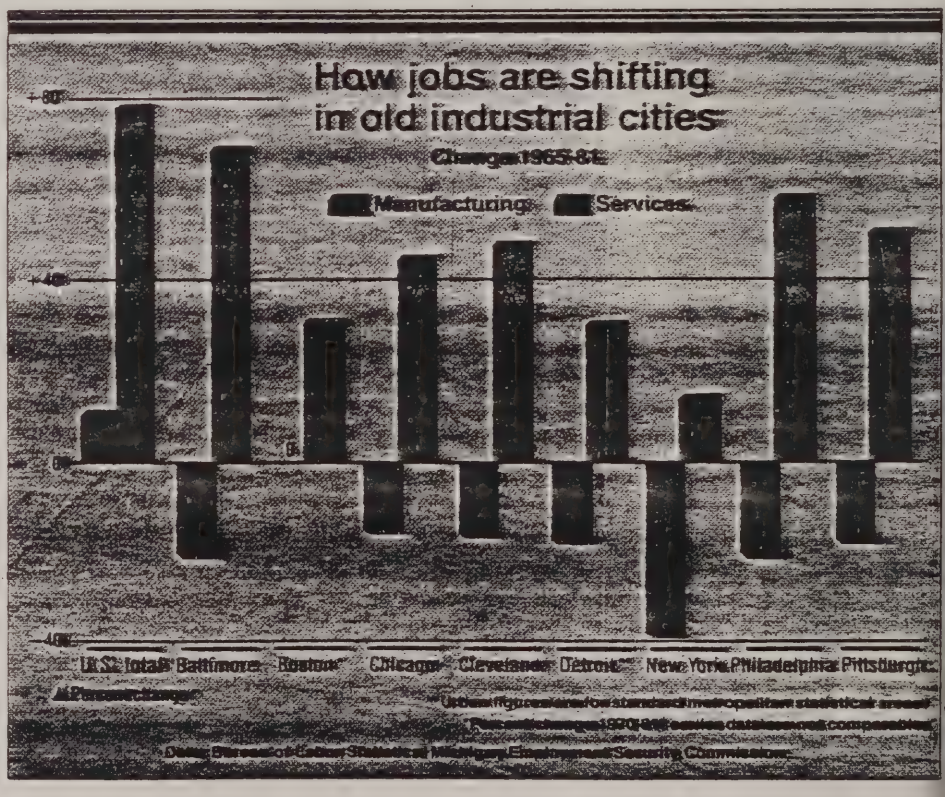
Many economists argue that unless there is a national reindustrialization program, efforts by cities to stem the loss of manufacturing jobs will prove unsuccessful. The Reagan Administration is strongly opposed to any such ideas, and in a recent detailed analysis of the economic future for urban areas it emphasized that the federal government's role should be minimal. Anita A. Summers, an economist at the University of Pennsylvania's Wharton School, says that, for example, under the administration of Philadelphia's former Mayor Frank Rizzo, the city tried to retain garment industry jobs by helping to build a garment industry center. This largely failed, she says, because even with modern facilities it proved impossible to compete effectively with other regions and imports.

Similarly, says George P. Roniger, a regional economist at Citibank, previous government policies in New York were aimed at saving manufacturing jobs rather than getting new service industries. "The economic development thrust until several years ago focused on manufacturing almost entirely. Had the government been more supportive of the service sectors, we might have retained more [corporate headquarters and activities]," he says.

Baltimore County has issued nearly $50 million worth of pollution-control bonds to help keep jobs at Bethlehem Steel Corp., its largest private employer. Even so, employment at the giant Sparrows Point plant has dropped to 13,200 from its peak of 31,000 in the 1950s. Although Boston was making direct efforts to gain or save jobs, the city's comeback occurred independently, says Lynn E. Browne, an economist with the Federal Reserve System. The emergence of such high-technology or information companies as Digital Equipment Corp. and Data Resources Inc. evolved from Boston's principal economic resource—education.

However, improvement of the city's infrastructure and its rebuilding of declining areas into shops, malls, and attractive housing are "contributing in an intangible way to our ability to attract professionals," says Browne. And Alexander Ganz, research director for the Boston Redevelopment Authority, says that this has been the case for many years. He contends that Boston went through a 30-year depression—ending only around 1960—during which the roads, public buildings, and waterfront deteriorated.

In April, Boston's unemployment rate was only 6.7%, well below the seasonally unadjusted national average of 9.2% and far under the city's 10.5% average in 1975. "One factor which helped was the rebuilding of the public infrastructure," says Ganz, "and there was also a basic



national economic factor—the services revolution. Boston had a good base to take advantage of that because of its investment in human resources through its universities."

Indeed, education will be one of the most important factors in enabling the nation's old cities to participate in the expected continued surge in service industries. Anthony Downs, an economist at the Brookings Institution, believes that California's excellent primary and secondary school system was a major contributor to its fast growth. But with Proposition 13 tax reductions under way, Downs thinks California's advantage will be lost, and Frostbelt cities will again be more competitive in attracting business. Yet funds for education are being cut back everywhere, and many city leaders concede that their educational systems are weak. Although Philadelphia is well-endowed with universities, for example, its public schools are saddled with a mediocre reputation.

Worry. In Detroit, too, bright hopes for such high-technology industries as robotics could founder on the shoals of budget cuts for post-secondary education. "If there is anything in all this that I am concerned about," says Trygve Vigmostad, deputy director of the Michigan Commerce Dept.'s Office of Economic Development, "it would be our ability to sustain our educational system."

Good education is a resource that all cities will need to rebuild their economies. But each city is also trying to build on unique strengths. New York, which has profited from its long leadership as the nation's chief corporate and finance center, is undergoing a building boom,

Economists warn that costly city efforts to assist manufacturing are likely to fail

with $2.5 billion worth of office buildings under construction in Manhattan. Growth is taking place, says New York's Deputy Mayor Karen N. Gerard, in three areas—international banking, professional services such as law and accounting, and culture and entertainment. As a result, unemployment in the New York metropolitan area is 8.3%, compared with an average of nearly 11% in 1976.

New York's new surge of growth began in 1977 after a long recession in the 1970s, which occurred because the city's costs got out of line with the rest of the country. As a result, the manufacturing sector shrank. But the service sector was able to grow because, despite the high costs of doing business in New York, gaining access to other companies provided important efficiencies.

Boston and New York are not alone in benefiting from the revolution in services. The Pittsburgh area is "slowly changing, moving out of being the forge shop of America into being a knowledge and management area," says Jay D. Aldridge, executive director of Penn's Southwest Assn., a business promotion organization. Already a major corporate headquarters center, Pittsburgh is counting on about $1 billion worth of private development, including new office buildings for such major companies as National Steel, Dravo, and PPG Industries to strengthen its role as a business service center. Furthermore, it plans to spend about $1 billion on a new subway, airport expansion, and other public improvements.

Even though U. S. Steel Corp. is trying to sell its headquarters building, the city's role as a corporate headquarters is providing a cushion against the devastating loss of jobs in the steel industry. Already, the city's largest employer is the University of Pittsburgh. In the past, says W. Lee Hoskins, chief economist at Pittsburgh National Bank, a steel crunch of today's proportions would have given Pittsburgh an unemployment rate twice the national average. Instead, it is 10.6% despite a 30% loss of jobs in the steel industry.

Philadelphia, too, has shifted to services, the sector where jobs have increased by 57% since 1965. As a result, the area's unemployment is 8.5%, a far

In Detroit, budget cuts in education may jeopardize a high-technology drive

cry from the higher-than-10% levels it reached in 1975. This shift has been so gradual, however, and the number of industries so diverse, that none dominates. "Philadelphia has always had a diversified portfolio," says Theodore Hershberg, director of the Center for Philadelphia Studies at the University of Pennsylvania. For future growth, Frederick Heldring, deputy chairman of Philadelphia National Corp., the city's largest bank holding company, says that the city is attracting foreign investment, such as a helicopter assembly facility owned by Agusta of Milan. And with a large network of universities that includes five medical schools, Henry Wendt, president of SmithKline Beckman Corp., believes it could become an international drug testing center.

Host role. Even hard-hit, auto-dependent Detroit expects its future to include a growing service segment. For one thing, officials believe it has a role as a host to industrial and technical conventions, and the city expects two hotels to be built near its downtown convention hall. In addition, officials believe that its local universities can provide research to serve autos, computers, food processing, and molecular science. "Michigan is diversifying respectably out of manufacturing," says David L. Birch, director of the Massachusetts Institute of Technology's program on regional change.

And while Cleveland executives insist that its chief competitive advantage will always lie in manufacturing, they recognize that the service sector will continue to grow, making the economy less volatile. The city's second largest employer is the Cleveland Clinic Foundation, a world center for cardiovascular surgery, which employs 7,400. By 1986 it is expected to employ more than 10,000 people. In addition, Cleveland's role as a corporate center will increase service jobs. Standard Oil Co. of Ohio will soon begin construction of a new headquarters in Cleveland, and it is now doubling the size of its research facilities in suburban Cleveland.

"There's a gradual, constant restructuring," says James M. Dawson, economist for Cleveland-based National City Corp. "This implies the manufacturing sector will be less important to the local economy." Similarly, Chicago's economic slide has been slowed by its role as a financial center, its burgeoning hotel business, and its relatively stable retail sector.

Attracting employees. But it is clear that the revitalization of a city's economy takes time. Baltimore, for example, has worked closely with business in recent years to redevelop its downtown. It garnered high praise for the renovation of its Inner Harbor, a joint public and private project on which $570 million has been spent so far. But city leaders were dismayed this spring when a study by Chase Econometrics revealed that metropolitan Baltimore lost more jobs last year than any other metropolitan area in

Pittsburgh's big shift: Away from plants and toward knowledge and management

the Northeast. Although officials challenge the precise figures, the implication of the study was that the massive development was not going to stem the outflow of jobs anytime soon.

Nevertheless, economists agree that over the long run the redevelopment will attract business. "It's just easier to attract employees if Baltimore is known as an enjoyable place to live," says David L. Purvear, director of the Public Policy Program at Johns Hopkins University. Furthermore, says Puryear, the joint commitment by business and government sends a message to the private sector that the city is willing to "minimize red tape and facilitate business in locating here." In time, such cooperation can go a long way toward establishing a strong employment base.

URBAN AFFAIRS
URBAN AFFAIRS

2 Areas Show A Path to Jobs In Technology

8/8/82

By FOX BUTTERFIELD
Special to The New York Times

BOSTON, Aug. 7 — With the decline of America's industrial midsection and its once proud steel and automobile factories, Americans are increasingly looking to high technology as the key to saving their states and businesses.

But a study of the two regions where high technology industry has enjoyed its most spectacular expansion, the arc of Route 128 around the rim of Boston and the electronics industry area south of San Francisco, suggests that their success may be hard for other states to emulate.

A series of special, interrelated factors appear to have helped these areas thrive:

¶Close ties between a major research university and new high technology companies in the area. While the Massachusetts Institute of Technology and Stanford University in California, encouraged their professors to work for local businesses, many other colleges have disdained such activity as crass commercialism.

¶A favorable climate or geography and attractive cultural amenities to lure the bright young engineers who form the backbone of high technology companies. Proximity to raw materials, such as coal and iron ore, and easy access to large markets that long gave the Middle West an advantage are not so important as brain power.

¶A pool of shrewd, imaginative venture capitalists to provide seed money and guidance for the high technology enterprises. Venture capitalists, unlike conventional bankers, participate in the management of the companies they invest in and do not expect to show a profit within the usual period of one to three years.

¶More flexible and paternalistic managers, who, like some Japanese executives, treat their employees as allies rather than adversaries and reward them with benefits like profit sharing, stock options and country club membership, even for manual workers.

¶A sort of critical mass effect achieved after high technology companies reached a certain density in the areas, enabling ambitious entrepreneurs to spin off new companies from old ones more rapidly than they could elsewhere.

In Palo Alto, for example, eight engineers who worked for the Shockley Transistor Corporation, set up in 1956 by Robert B. Shockley, the co-inventor of the transistor, left a year later to form Fairchild Semiconductor. Fairchild was the first company to manufacture the wafer-thin silicon chips from which the area got its nickname of Silicon Valley.

In turn, more than 40 other companies have been established by alumni of Fairchild, including Intel and National Semiconductor, two of the largest producers of microchips. In Massachusetts, Data General, a maker of minicomputers for business use, was set up by Edson de Castro, an engineer in his late 20's who seceded from Digital Equipment Corporation.

Development in Other Regions

Other parts of the country have also begun to develop clusters of high technology factories: Minneapolis, the Raleigh-Durham area in North Carolina, Dallas and Austin in Texas, Phoenix, the Boulder-Denver region of Colorado, Beaverton in northern Oregon, and Los Angeles and San Diego.

However, there is no great boom around New York, which Stanley E. Pratt, editor of Venture Capital Journal, believes is attributable in part to the lack of a university with strong engineering and science departments that have allowed their professors to work closely with business.

He thinks that lack is why, even though New York has 20 percent of the country's total venture capital funds, investment in high technology companies in New York State accounted for only 65 percent of that money, with the other 35 percent being invested elsewhere in the country.

Mr. Pratt, whose office is in Wellesley, Mass., just off Route 128, said that from 1970 and 1980 only Massachusetts and California had a positive inflow of venture capital.

Investments on Two Coasts

California accounted for 28 percent of the nation's venture capital investments in the decade, though it had only 15 percent of America's venture capital resources, while Massachusetts attracted 15 percent of the country's venture capital activity with only 10 percent of its resources.

Venture capital bankers say it is much harder to arrange deals in the newer areas than in Massachusetts or California.

"I did a deal in Columbus, Ohio, last year," said Lawrence G. Mohr, a partner in Hambrecht & Quist, a leading San Francisco venture capital company. "But it was agony because the attorney there didn't know what venture capital was all about and kept worrying about the S.E.C." His reference was to the Securities and Exchange Commission.

Mr. Pratt is a passionate partisan of the importance of new high technology companies in the American economy. Of the nine million jobs created from 1966 through 1976, he said, six million were developed by small businesses and three million by the government.

The total number of employees in the 1,000 largest companies did not increase by a single person in that period, he asserted, adding, "It gives you an idea of where the vitality is in our econ-

This situation has changed somewhat now because a number of the high technology companies have moved into Fortune magazine's list of the top 500 companies in the United States in terms of revenue.

Although the Route 128 area and Silicon Valley have developed into the two largest high technology zones over the past two decades, they originally had little in common. Massachusetts, the home of America's first industrial revolution in the early 19th century, with its water-powered textile mills, had been in an economic slump since the end of World War I. Silicon Valley, along the southwestern shore of San Francisco Bay, was a tranquil preserve of apricot, cherry and prune orchards.

But today the two regions share a success reflected in a number of statistics. High technology industries in Massachusetts employ 250,000 people, one-third of the state's manufacturing labor force, and had sales last year of $19.5 billion, by an estimate of the Massachusetts High Technology Council.

Electronics plants in Silicon Valley employ 161,000 people, according to a study by the Crocker National Bank of San Francisco, and had sales of more than $10 billion in 1981. From 1975 through 1980, electronics-related jobs in Silicon Valley soared 93 percent.

Large Annual Jumps in Sales

Two of the fast-growing concerns are Wang Laboratories Inc.; in Lowell, Mass., a leading maker of automated office equipment, and Tele Video Systems Inc. of Sunnyvale, Cal., a mass producer of cathode ray terminals for computers. They are among a number of high technology companies with sales jumping by more than 40 percent annually, and, because of such growth, the two regions are expected to keep their vibrancy.

The catalyst in both regions, executives and engineers agree, was the presence of good universities willing to let professors work with private business.

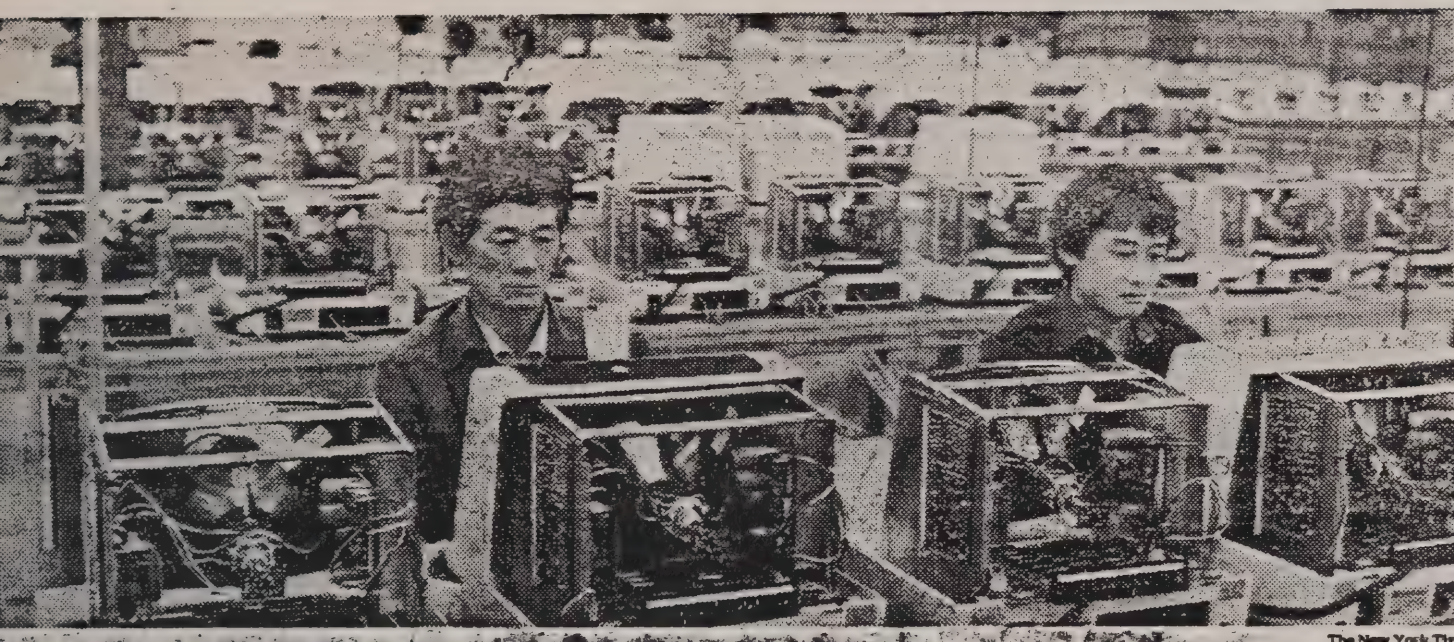
In Massachusetts, one of the first electronics companies was Raytheon, established in a small laboratory in Cambridge behind M.I.T. in the 1920's by two men who had been roommates at Tufts University in nearby Medford. One of them, Vannevar Bush, later went on to become chairman of the M.I.T. Corporation.

A number of the companies now strung out along Route 128 north and west of Boston grew out of research by engineers at M.I.T.'s Lincoln Instrumentation Lab, which did pioneering work on radar, missile guidance systems and computers in the 1940's and 1950's. Among these was Kenneth Olsen, the founder and chairman of the Digital Equipment Corporation.

Links to Harvard

A smaller number of companies have been started by scientists from Harvard, including Edwin Land, the inventor of the instant camera and founder of Polaroid, and An Wang, the founder of Wang Labs.

At Stanford, Frederick Terman, an energetic professor of electrical engineering, encouraged some of his students to start companies near the campus in the late 1930's to end the brain drain of West Coast engineers to the East. Among Dr. Terman's first



The New York Tir

Workers assembling video display terminals at Tele Video Systems Inc. in Sunnyvale, Calif., an area that has attracted high technology comp

protégés were William R. Hewlett and David Packard, who set up shop in the Packard garage in 1937. Their company, Hewlett-Packard, has become one of the largest makers of computers and electronic instruments.

E. David Crockett, a senior vice president of Dataquest, a supplier of information and research for the computer industry based in Cupertino, Calif., recalled that when he was an executive of Hewlett-Packard one criterion for selecting a new site for a company plant was "to be near a first-rate university." When Hewlett-Packard ignored this rule and put two divisions in Boise, Idaho, the plants ran into trouble and special classes had to be taped for their engineers back at Stanford.

Propinquity to a good university and university town are also important as an attraction for the scientists and engineers in a high technology company. Sandra L. Kurtsig, the founder and president of ASK Computer Systems, a leading software company that provides the programs that make computer hardware useful, located her company in the lush suburb of Los Altos, near Stanford, because most of her 120 employees are young engineers "who like the university culture and come from Stanford or Berkeley."

Although Boston lacks California's sunshine, it has good beaches from Cape Cod to Maine in the summer, skiing in the mountains of Vermont and New Hampshire in the winter, a plentitude of restaurants, shops and museums and the greatest concentration of colleges in the country.

Boston, along with San Francisco and New York, is one of the three main centers of venture capital, the new form of banking that developed in the late 1960's.

"The venture capitalist, unlike the traditional banker, joins the board of the company he invests in and actively participates in its management," said Mr. Pratt of Venture Capital Journal. He has to have a longer time frame than other businessmen because even successful new high technology companies will generally show losses in the first three years.

These differences are important, Mr. Pratt insisted, and may help explain why a city like Atlanta, which has an excellent engineering school in Georgia Tech, has not produced a group of high technology companies. "Atlanta has the university and the money, but the businessmen there have a terrible risk aversion because they lost their absolute shirts in real estate in the last decade," Mr. Pratt said.

The venture capital business is still very small, with only $5.8 billion in investment funds, as against about $750 billion in assets held by pension funds alone. But the rewards can be great.

Burton J. McMurtry, a general partner of Technology Venture Investors, a venture capital concern in Menlo Park, Calif., invested $1.1 million in the ROLM Corporation in 1970. In 1980 he distributed about $37 million worth of stock to his partnership from ROLM, a manufacturer of computerized telephones. Two earlier investments were similarly successful.

Equally important for the development of high technology industry has been the style of its managers, which encourages worker loyalty and innovation. ROLM, down Highway 101 from Stanford in Santa Clara, has built a $1 million sports complex that is used by two-thirds of the staff.

At ASK, Mrs. Kurtzig is referred to informally as Sandy by the receptionist in the company's handsome sandstone-colored ranch-style headquarters. "People are our whole company," she said. "We don't manufacture, so we have to be people-oriented to keep our work force."

Profit Sharing and Beer Parties

This means that everyone on the staff has profit sharing, which amounts to about 10 percent of their annual base salary, all professionals get stock options and every Friday afternoon there is a beer party paid for by ASK.

Virtually none of the high technology companies in either Massachusetts or California have unions, and only about 30 percent of the work force in these companies is in manufacturing jobs, according to Marshall Goldman, a professor of economics at Wellesley College. The bulk of the employees are in sales and service or research, Professor Goldman noted, which has major implications for the future of unions.

But if high technology is bad news for unions, it is good news, Mr. Pratt believes, for the future of the recession-plagued Middle West. The region can be the center of the newest branch of high technology, robotics, he said, "since robotics must start at the production end." Looking into his own computer, which follows the progress of 3,000 venture capital projects, Mr. Pratt predicts a surge in high technology growth for Chicago and Cleveland.

COMPUTER MANUFACTURING IN NEW ENGLAND

Some of the facts about the computer industry are truly amazing. For example, if price-performance ratios had fallen similarly in the automobile industry over the last few decades, a Rolls Royce would cost $2.25 today. And spokesmen from one company say that new products and product modifications come out at a rate of one every ten to twelve working days.

Facts like this abound in the industry, but a complete, analytic survey is harder to come by: How did the computer industry develop? How does it function? What are the stresses on its development and what sorts of policy measures ought to be taken to better integrate it within the economy? are some of the questions that ought to be asked.

The latest case study from the Joint Center's research on the transformation of the New England economy, released this month, is just such a survey. *Computer Manufacturing in New England: Structure, Location, and Labor in a Growing Industry,* by Sarah Kuhn, describes and documents the dramatic rise of the computer industry, its changing structure, and the effects of competition and maturation on its development patterns. The report is the most complete picture to date of the industry as it functions within a regional economy.

Kuhn has analyzed the computer industry first in terms of its segments — from mainframe and minicomputers to semiconductors, jobbers, and services. She describes each segment, the problems in classifying different products, and the cross-overs that occur as companies enter more lines of business and become more complex entities, all within a very short span of time. As Kuhn points out, it is the interplay among the industry segments which gives computer manufacturing its dynamic character.

Firm size is one of the important factors that play a role in shaping the character of the industry. Smaller-sized, less-diversified firms are the ones that have perhaps given the industry its image. These are the new firms that have entered the markets by virtue of a newly invented product. Even in times when venture capital seems to be at a premium, these new, small companies have a much easier time getting started today than do their counterparts in other industries.

The larger companies have grown to their new size over the last decade by expanding and integrating vertically, so that by 1979 two-thirds of the entire industry's employment was in branch plants of multi-plant firms. Semiconductor production, one of the most rapidly changing areas of computer manufacturing, is a particular target for vertical integration. In semiconductor production, computer companies are continually looking for ways to reduce inherent uncertainties in chip supplies, protect proprietary information, and economize on research and development expenditures.

Kuhn says vertical integration, however, may have its drawbacks. Innovation is the hallmark of the chip industry, and some analysts have worried about the effects of buy-outs on the flexibility and drive that have been characteristic of semiconductor companies.

The computer industry, like some others, tends to concentrate activities within a few large firms as it grows. In the mainframe segment, for example, IBM's service and distribution systems are formidable competition, as is its long track record. IBM's share of the small computer market is twice as great as its closest competitor, Digital Equipment. Whether other companies can continue to compete with such giants by varying market strategies or introducing new product lines is a real issue. Kuhn surmises that there is little reason to expect that the minicomputer segment of the industry will escape the typical cycle for manufacturing companies: expansion, over-expansion, contraction, and finally the disappearance of the weaker companies. The computer industry, she says, may be even more susceptible than other manufacturing sectors: typical contraction will be enhanced in computer manufacturing by the rapidly growing cost of production machinery, the industry's unusually high capital needs, and factors like economies of scale, particularly in software development and service networks.

Competition among firms is intense, as one might expect. Companies battle along lines of pricing (particularly in the semiconductor segment); service support systems and guarantees; and marketing strategies employing retail stores, emphasizing availability, and offering software packages. At the same time companies have to hold onto proprietary information and contend with second sourcing and foreign competition.

The intensity of all these factors, combined with the heavy use of capital in the industry, means that managers face enormous challenges that demand a combination of technical knowledge of the field and a sense of business organization. Many of the most successful firms, Kuhn finds, retain their founders in top positions for years. These CEOs are engineers or scientists who have not only technical expertise but also a certain interest and talent for entrepreneurship.

Location Decisions

Probably one of the most critical aspects of the business which company heads must nurture is research and development. Firms generally spend large portions of their earnings on research, and small firms seem to generate proportionally more product innovations than larger firms. One of the most important resources for R&D has been the universities. Just in Massachusetts alone, in 1979, 300 computer-related firms were located within two miles of MIT. And 156 of the 216 high-tech firms counted in another report as being in the greater Boston area came from the Institute's laboratories and departments.

Kuhn makes the point that location considerations other than proximity to universities do come into play. Start-up

locations are often determined by idiosyncratic factors. The relatively insignificant transportation costs connected with computer manufacturing mean that the industry is free from some of the locational constraints with which other manufacturing firms must contend. An important location consideration, however, is access to labor, both skilled and semiskilled.

Companies needing technical professionals tend to expand where these professionals already live — often in university communities. Companies that produce more standardized products are less tied to locations near the big universities on the two coasts. Most of the big mainframe companies, begun twenty years ago, are located in New York and Minnesota. Semiconductor companies are the ones that tend to look outside the country for cheap labor pools.

Land availability is not really a critical factor in these location decisions. Computer companies are not particularly restricted in the types of land they need. Multistory, in-town renovated buildings often work just as well for some purposes as giant, one-floor structures in suburban industrial parks. Locations must have good truck access, though, between plant and airport since many parts and products are shipped by air. The areas of the industry that have traditionally been most sensitive to location, sales and service, are also affected as high technology itself expands their capabilities. Telephone lines, for example, are making possible remote diagnosis of hard- and soft-ware failures. Still, it would be hard to envision a time when repair service divisions will not have to dot the landscape close to the range of sites that markets comprise.

One of the most hotly debated issues is the role of taxes in the location decision. Kuhn agrees with observers of other types of industries that state and local taxes are not high on the list of site considerations for computer industries looking to branch into other domestic locations. Tax and tariff considerations do play a major role, however, for companies seeking to locate abroad.

Who Works in Computers?

According to Kuhn, perhaps the most important product of the computer manufacturing industry is not computers but jobs — both skilled and unskilled. Small, new companies tend to be top heavy with professionals. As those companies develop, the proportion of professionals drops. The larger companies end up with a large proportion of production workers relative to professionals.

The growth of the industry is changing not only general employment patterns but employment practices as well. Some companies, Kuhn reports, but not all, are taking advantage of their growing size to standardize work rules and put in place a tight management structure. This hasn't become a general rule, however, since companies are well aware that tight structures may limit creativity, which is the name of the computer game.

Also, the entire computer industry is concentrating now on mechanizing its systems. Because the industry has supplied an important number of jobs in New England, particularly in Massachusetts minicomputer firms, the long-range effects of this will be extremely important. Mechanization could slow the present very rapid rate of expansion in some parts of the industry's workforce.

R&D efforts to increase this mechanization apply to all aspects of the industry: testing equipment, mechanical software generators, mass-produced software packages, remote software debugging, and other repair equipment are some. Even the design of computers can be aided by computerized systems. To date, marketing remains the least automatable task.

At present, figures indicate that one out of every three workers in the industry is a woman. Figures also document that, as in all industries nationwide, these women are overrepresented at the lower end of the job and pay scales and under-represented at the upper end. In California, women are reported to hold a full 90 percent of the lowest paid and most hazardous jobs in the industry — semiconductor assembly. Nationwide, so few women are classified in the two highest-paying programming categories that the Bureau of Labor Statistics cannot report their numbers or salaries. Kuhn reports that the situation for women has not gotten better over time. Her data suggest that the earnings gap between men and women may even be widening.

Information on minority employment is also sparse, to say the least. Reports suggest a heavily female, heavily Latin and Asian workforce in semiconductors in California; parallel figures for New England simply do not exist.

Public Policy and Computers

The computer industry developed by impetus from the federal government, and the federal government remains one of the industry's best customers today. Historically, government patronage has been key to the problem of getting prices of new products down to competitive levels. The government is key in other areas as well — funding research, offering patent protection and antitrust laws, and maintaining import/export policies. The industry still has a list, though, of its best hopes for increased government help. Among these are tax incentives for R&D, reduction of capital gains taxes, help with new business development, and reduction of trade barriers.

Aside from proper infrastructure and an assurance of capital, there are two very important issues under debate in New England. One is whether personal income taxes affect technical professionals' decisions to settle here. The figures at Kuhn's disposal and the personal interviews she has held lead her to believe that lowering taxes would not play a significant role in attracting professionals to the region or keeping them here. She finds that comparison of state income taxes alone overstates the relative cost of a Massachusetts residence for the industry's professional employees. Furthermore, professionals look beyond taxes to the far less quantifiable benefits of jobs and their locations. Quality of life — intellectual and cultural — is a chief criterion for them. Lowering personal taxes, says Kuhn, would only jeopardize the very features which make Massachusetts attractive to professionals — good educational systems and public service, for example.

The other important issue is who pays the bills for skill training. The industry is already suffering a nationwide skill shortage. Because Kuhn's data suggest that professionals are less likely to move between regions than commonly believed, she argues that local degree-oriented and skill-training programs are necessary to meet the high demand for labor. Lowering taxes would cut into the public sector's ability to train technical workers.

Kuhn concludes that at present New England remains a good place to start up or expand a computer company. New companies and R&D facilities are attracted by the infrastructure and agglomeration advantages of Boston and the city's heavy concentration of educational institutions. At the same time, many areas of New England offer pools of skilled and unskilled production labor at wages well below those of most competing states. The combination of access to highly skilled professional labor and low-wage but skilled workers makes New England an attractive area for companies whose products remain sufficiently unstandardized that locating production near R&D facilities remains an advantage.

While pointing to the attractions that the region holds for the industry, Kuhn also raises questions about the possible negative effects of the computer industry on the region's overall economy. In her concluding paragraphs she outlines some of the potential risks in heavily promoting an industry that has been able to pay below-average production wages while at the same time advocating substantial personal tax reductions.

SELECTED INDUSTRY REPORTS ON RECENT TRENDS AND FUTURE PROSPECTS AND PLANS IN THE COMMUNICATION-INFORMATION-KNOWLEDGE INDUSTRIES

From an Article by Anthony G. Oettinger, Chairman of the Program on Information Resources Policy, Harvard University, Entitled "Information Resources: Knowledge and Power in the 21st Century", Published in Science, July 1980

Table 1. Annual gross revenues of the major information industries. Symbols: a, government statistics are routinely compiled for this industry but were not yet available for this year; b, industry statistics consistent with those for the following years are not available; c, major league sports are as intimately linked to the television industry as motion picture production and therefore qualify for inclusion. The organizations are, however, generally privately held and, except for a rare special study, data about them are not available; d, statistics are routinely compiled for only some types of libraries; e, figures are not normally released by the government but became available for prior years through congressional hearings.

Information industries	Approximate gross revenue (in billions of dollars)				
	1970	1974	1975	1976	1977
Telephone	18.2	28.3	31.3	35.6	40.8
Telegraph	0.4	0.5	0.5	0.5	0.6
Specialized common carriers	0.0	0.0	0.0	0.1*	0.2*
Satellite carriers	0.1	0.1	0.1	0.2	0.2
Mobile radio systems	2.0	2.9	3.2	3.5	a
Postal service	6.3	9.0	10.0	11.2	13.0
Private information delivery services	0.7†	1.3†	1.6†	1.7†	2.4†
Pulp, paper, and board	13.0†	17.1†	a	a	a
Photographic equipment and supplies	3.9†	6.0†	a	a	a
Radio, TV, and communication equipment	12.8†	16.8†	a	a	a
Electronic components and accessories	12.8†	20.3†	a	a	a
Computer systems manufacturers	b	16.6	18.8	21.1	23.8
Computer software and service suppliers	1.6	3.2	3.8	4.5	5.3
Broadcast television	2.8	3.8	4.1	5.2	5.9
Cable television	0.3	0.6	0.7	1.0	a
Broadcast radio	1.1	1.6	1.7	2.0	a
Motion pictures	3.8	5.5	5.4	a	a
Organized sports, arenas	1.0*†	c	c	c	c
Theaters	1.5	2.5	2.7	a	a
Newspapers and wire services	7.0	9.6	10.5	11.7*	13.4*
Periodicals (including newsletters)	3.2	4.1	4.4	5.0*	5.6*
Business consulting services	0.9	1.7	1.8	a	a
Advertising	7.9	9.7	10.0	a	a
Brokerage industries	40.6	64.0	69.1	a	a
Book publishing and printing	3.4	4.5	4.8	5.2*	5.6*
Libraries	2.1	d	d	d	d
Schooling	70.1	97.7	110.8	121.4	130.6*
Research and development	25.9	32.7	35.1	38.5	42.7*
Federal information institutions					
Census Bureau	0.1	0.1	0.1	0.1	0.1
National intelligence community	4.0*†	7.0*	10.0*†	6.0*†	e
NTIS‡	0.0	0.0	0.0	0.0	0.0
Social Security Administration	1.0	1.9	2.2	2.6	2.7
County agents, government	0.3	0.4	0.4	0.5	0.5
Banking and credit	61.1	136.2	132.7	a	a
Insurance	92.6	133.1	148.8	a	a
Legal services	8.5	13.7	14.8	a	a

*Estimated. †Lower bound. ‡National Technical Information Service.

From Communications News, January 1982

USA Communications Forecast for 1982

	1980 ACTUAL	1981 ESTIMATE	1982 FORECAST
Telephones in service	180,180,000	185,500,000	191,100,000
Telephone plant expenditures	$21.8 billion	$23.5 billion	$25.7 billion
Radio stations	8,881	9,089	9,100
Television stations	1,021	1,040	1,055
CATV systems	4,225	4,400	4,750
Radios in use	460,000,000	463,000,000	466,500,000
TV sets in use	162,500,000	168,300,000	172,500,000
Homes with TV	75,793,500	76,200,000	77,100,000
Homes served by CATV	15,158,700	18,000,000	21,000,000
Radios manufactured, auto	9,622,000	8,600,000	9,100,000
Radios manufactured, AM	8,752,000	8,400,000	8,100,000
Radios manufactured, FM	28,974,000	29,500,000	30,400,000
TV sets manufactured, monochrome	6,729,000	6,800,000	6,900,000
TV sets manufactured, color	11,803,000	12,100,000	12,500,000
Personal radio stations	13,632,475	13,400,000	13,200,000
Amateur radio stations	392,109	393,100	394,000
Aviation radio stations	233,169	241,500	248,000
Industrial radio stations	583,503	662,400	671,500
Public safety radio stations	155,227	175,800	183,600
Marine radio stations	399,835	421,400	435,900
Transportation radio stations	31,740	35,500	41,800
Total electronics market . . .			
Consumer	$10.9 billion	$11.5 billion	$12.2 billion
Communications	29.5 billion	35.0 billion	41.5 billion
Industrial	38.9 billion	44.2 billion	49.5 billion
Components	25.3 billion	30.1 billion	35.0 billion
TOTAL	**$104.6 billion**	**$120.8 billion**	**$138.8 billion**

From Communication News, 1982, Various Issues

BY 1990:

1. Video home banking will be in use in 8 million American homes.

2. The Videotext market will exceed $9 billion and will penetrate between 15 and 20 million homes.

3. The video teleconferencing system will have grown 10-fold (fueled by sharply rising travel costs). Total end user expenditures on teleconferencing will leap from $50 million in 1980 to $900 million. Products are already being introduced onto the market through teleconferencing. Volkswagon introduced its 1982 line to distributors gathered at 30 Holiday Inn conference rooms.

4. Total cable revenues will reach $26.2 billion (up from $2.82 billion).

5. Over 11 billion messages will be sent via electronic mail (by 1995) -- up from 930 million in 1980, creating a $5.7 billion U.S. market for electronic mail equipment. By 1991 almost half of all white collar workers (about 24 million) may be using electronic mail.

TELECOMMUNICATIONS TOPICS

Notes on Status and Future Developments in

Evolving Telecommunications Technology

Optical Fiber Transmission Systems for Telecommunications

Communications Satellites

Software

Integrated Circuits

Viewdata and Teletext Services

Teleconferencing

Television and Cable TV

Functional Obsolescence and Value Erosion

E.B. Carne
J.M. Ciano
March 1981

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COMMUNICATIONS PRODUCTS TECHNOLOGY CENTER
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SECTION VIII

TELEVISION AND CABLE TV

On June 4, 1980 Comsat General Corporation announced formation of a subsidiary, Satellite Television Corporation, as its vehicle to pursue the development and offering of a satellite-to-home subscription television service. The proposed service would offer multiple channels of entertainment and information to U.S. consumers for a monthly subscription fee, and would supplement existing commercial television service available to American viewers.

Communications Packets

TELEVISION: Almost 400 million television receivers, worldwide, are served by 6700 TV broadcasting stations. Almost one-half of all stations are in Europe and one-third are in the Far East. All major countries now have a television service. In the US: 98% of all households have at least one television receiver; 93% of TV households receive at least one UHF station; 77% of TV households have at least one color receiver; and 47% of TV households have two or more receivers (BW or color). Of almost 1000 TV broacasting stations in the US, 62% are VHF (38% UHF), and 73% are commercial (27% non-commercial). The average American TV household (2.8 persons) watches just over six hours of programming a day.

CABLE TELEVISION: In the US, some 4000 cable systems offer 30,000 program channels and serve 13 million homes. Another 1200 systems are approved, but not built. Eighteen percent of the nation's TV households subscribe to cable at a monthly charge of $6 - $15. Cox Cable in San Diego is the largest cable system (148,000 subscribers) and Teleprompter is the largest MSO (multiple system operator) with over one million subscribers. Pay cable is on approximately 604 systems

and reaches 1.6 million subscribers in 46 States. Fifty-five systems claim to offer two-way services.

PROJECTIONS: In 1985, the US is estimated to have: 220 million TV receivers; 66% of all households will have two or more TV receivers ; on average, each household will have 2.6 TV receivers ; 98% of all receivers will be color; as few as 29% and as many as 46% will be connected to cable ; and 1% will have video recorders/players. Between 1974 and 1979 cable revenues rose from $730 million to $1.5 billion and are expected to reach $2.9 billion by 1984.

TELEVISION TECHNOLOGY

SIGNAL STANDARDS: The historical development of television services has led to the adoption of several standards. To some extent they are affected by the fundamental power frequency, but mostly they represent the reproducible state-of-the-art at the time the service was introduced. Thus, frame rates are 25 or 30 per second, line frequency varies from 450 to 825 lines per second, and three basic techniques (NTSC, PAL, SECAM) exist for encoding color. Because standards tend to follow national boundaries, cable television is of particular interest in the frontier zones, since it can perform transformations at the head end which allow foreign transmissions to be reproduced in a common format. Of the three coding schemes for color television: North America and Japan use NTSC; France, Soviet Union, and Eastern Europe use SECAM; and most of the rest of the World uses PAL.

DIGITAL TV: By the mid-1980s, digital video processing and transmission between camera and transmitter may be commonplace. By that time, receivers with framestores could be on the market. It is unlikely, however, that the broadcast signal will be converted to digital in this time frame. In 1977, Britain's IBA demonstrated the major elements of a digital studio chain including mixer, switcher, tape-recorder and color-bar generator. The eight-level code, with sampling frequency of four times the PAL color subcarrier (4.3 MHz), is said to produce excellent color images. Also in 1977, Comsat Laboratories demonstrated satellite transmission of an NTSC video signal, together with program audio, 60 telephone voice channels and a digi-

tal channel, multiplexed on a 43 Mb/s serial data stream. Differential pulse code modulation (DPCM) was used to achieve approximately 2:1 video data reduction. The BBC has reported a similar demonstration in which PAL television and sound signals were multiplexed onto a 60 Mb/s serial bit stream and transmitted over INTELSAT IV. NEC has announced Band-Compressed Digital TV terminals. NETEC-22H uses interframe coding to transmit a NTSC studio color video signal with stereo audio channels at 22 Mb/s. NETEC-16 compresses a 'high-quality' color video signal plus audio into a 16 Mb/s stream. NETEC-6 transmits a 'crystal-clear' color video signal (with audio) at 6.3 Mb/s, albeit with some degradation of detail and motion.

CABLE TELEVISION

TAMA NEW TOWN, JAPAN: A twenty-month demonstration (1976-1977) was sponsored by the Ministry of Posts and Telecommunications to test the use of coaxial cable bringing two-way communications to several hundred homes in an attempt to regain 'a sense of togetherness.' Besides regular television, the system provided ten innovatons, including: local origination; flash information, such as news, weather, sports results, etc., which is superimposed on the regular television picture; and broadcast response, a two-way information exchange service in which viewers can respond to original telecasting.

HIGASHI-IKOMA, JAPAN: The HI-OVIS Video Distribution Field Trial is the first major attempt in moving optical fiber into the loop plant. Installed in July 1978, the system provides cable TV and a wide variety of other video programs to 158 homes in a suburban community near Osaka, Japan. No telephone service is provided. The network uses a centrally switched star configuration with one program center and one subcenter colocated with the center. A two-fiber cable is used as the subscriber drops and a 36-fiber cable is used for distribution. Copper wires are included in both cables to facilitate communications during installation. The system offers full two-way interactive video communications.

One baseband video signal is transmitted over the fiber in both downstream and upstream directions. A 200-bit/s data signal, amplitude modulated at the carrier frequency of 6.6 MHz, is also multiplexed onto the

upstream path for video program selection and control. A 30 X 68 matrix type broadband switch is used for switching of video programs. For flexibility, a fiber distribution frame and a branch box, similar in concept to the present main distribution frame (MDF) and jumper wire interface (JWI), respectively, are employed. Test results of the trial indicate that the reliability and performance of the fiber distribution system fully met or exceeded the expectations. The subscribers' responses to the programs and services offered are reported to be encouraging. A similar, but much larger, project is being planned.

QUBE SYSTEM: On 1 December 1977, Warner Amex Cable Corporation began operation of the QUBE system in Columbus, OH. QUBE is a pay-TV option, which differs from conventional systems in that cable subscribers can buy 'on impulse' by pressing the appropriate buttons on a hand-held control unit. QUBE has additional features which allow viewers to 'talk-back' to the studio by pushing buttons on their control units - - placing bids for items offered at auction, selecting football plays, balloting on civic questions, or choosing answers in courses given for school credit. A security system, consisting of a burglar alarm, a fire alarm and a medical alert system, is also offered. An energy management system to control heating and air conditioning is in development. Presently, Warner Amex is experimenting with Teletext information retrieval services in its Columbus, Ohio QUBE system.

QUBE service currently consists of 30 channels of video programming which includes several channels of per-program pay-TV, interactive video programming and narrowcasting, or the ability to direct a specific program to a select group of subscribers, excluding all others. At present there are 32,000 subscribers to QUBE, each paying $10.95 per month for the service.

Warner Amex Cable Corporation is planning to set up a second QUBE system in Houston, TX, covering 200,000 homes. Service will begin in 1980, but the installation will not be complete for four years.

Recently Warner Amex has announced plans for a multimillion dollar cable television facility in Pittsburgh, PA., featuring two-way interactive QUBE service. In addition to QUBE service, the 80-channel CATV system will include such subscriber services as home security for fire, burglar and medical alert. Full-scale QUBE operations are scheduled to go into service in late summer or early fall of 1981.

DAYTON, OH: In the spring of 1978, six communities in the Dayton area became interconnected by a pair of cable systems, which are actually two systems in one. The main system is a conventional residential installation carrying TV stations, pay-TV and public access channels. The other is a 36-channel two-way system that ties together all the institutional buildings of the cities, permitting face-to-face communication between people in the buildings. The institutional cable system is intended for use in emergency medical care, medical diagnoses, high school equivalency and other health and educational services.

MANITOBA TELEPHONE SYSTEM: Manitoba Telephone System in Winnipeg has placed in service what is reportedly the world's longest coaxial CATV trunk system linking Winnipeg with four rural communities. The two largest cities involved, Winnipeg and Brandon, are 145 miles apart. The system will deliver television and FM broadcast signals to CATV companies in the rural communities. Low distortion amplifiers provide high quality bi-directional CATV signal transmission of up to eight channels in the forward direction and four in the reverse. Future potential services of the system include high speed data, teleconferencing, medical and educational television and telephony.

BERLIN FAIR: An experimental interactive Cable TV system offering about 40 services was presented at the Berlin International Broadcasting Fair of 1979. Among the services were TV programs, a public access-program with broadband channels from subscribers to the studio, and about 30 dialogue services in the field of information, education and entertainment, supported by still and moving pictures and auditive announcements.

The presentation enabled social scientists of the Henrich-Hertz-Institut for the first time to empirically investigate the acceptance and the attitudes of untrained exhibition visitors towards a system with such a variety of new services. In answer to the question which programs or services would be judged most acceptable, the majority named (in order): interactive information services, the open channel, the opportunity to receive the regular TV programs with excellent quality, instructional services and the local TV program.

DOW JONES: During the summer of 1980 Dow Jones and three other companies began testing an information

retrieval service that uses home computer terminals. Participating in the experiment are Sammons Communications, Inc., the nations largest privately owned cable TV company; A. H. Belo Corp., publisher of the Dallas Morning News; Merrill Lynch & Co., the brokerage and financial-services company, and Dow Jones, publisher of The Wall Street Journal, and other publications. As part of the experiment, 200 cable television subscribers near Dallas have access by cable to business, financial and general news. Participants are able to view current news and sports stories, general investment information, local restaurant and entertainment guides and business news published within the prior 90 days by Dow Jones News Services, The Wall Street Journal and Barron's National Business and Financial Weekly. Users also are able to call computer programs with which to evaluate personal investment portfolios.

TOCOM, INC.: Tocom, Inc. of Woodlands, TX, has built a two-way cable system whereby every house has two television outlets, a smoke detector and four medical and police alarm buttons. At a cost of $300 for the home terminal unit and a $5 monthly charge, residents can connect these security devices and others to a central computer. Also offered are 11 TV channels at $7 per month.

DIAL- A -PROGRAM: The first local wide-band switched cable network for public use anywhere in the world has been installed in Arnhem, The Netherlands, by Rediffusion, Ltd. and Deltakabel by agreement with the Dutch PTT. It has a capacity of 24 channels, expandable to 72 channels. Some 400 households receive five TV channels and six FM radio channels.

DIRECT SATELLITE BROADCASTING

In an initial step toward direct satellite-to-home television broadcasts, the Federal Communications Commision asked for public comments on recommendations by its staff for establishing such a service. The most radical of the staff proposals called for exempting broadcast satellites from nearly all FCC controls. They would be free for example, from program restrictions currently imposed on radio and TV stations, such as those limiting the amount of advertising, mandating public service programming and requiring stations to exercise "fairness". Perhaps more important, they would be free from FCC restrictions on cross-ownership by newspapers, cable TV companies and TV networks.

Information Resources: Knowledge and Power in the 21st Century

Anthony G. Oettinger

Summary. Every society is an information society and every organization an information organization. Hence information is a basic resource like materials and energy. The need to ask "Who has a resource? Who wants it? How can you get it? and What are the terms of trade?" links any resource to political or economic power. For information resources, traditional answers are now inadequate owing to the growing abundance and versatility of the fruits of our unprecedented engineering mastery over the microscopic information processes embodied in devices such as large-scale integrated circuits and microcomputers. Illustrative of the evolution of new answers and of their import are the consequences of competition within and between the computer and telecommunications industries, of our reliance on satellites and other technical means for both the prevention and the conduct of war, of the growth of information occupations relative to other jobs, and of domestic and international struggles over freedom of information versus control over it.

By widening the range of possible social "nervous systems" the continuing growth of information resources is upsetting the world order just as the Industrial Revolution upset it by widening the range of physical modes of production. Where this will lead is as hard to foretell as predicting today's world when the steam engine was invented. However, the timeless truth that knowledge is power once again needs reinterpretation because of newly abundant, varied, and versatile modes of gathering, storing, processing, transmitting, and exploiting information that contrast with ever scarcer and costlier materials and energy. Why this is so is illustrated first by showing how changing prices of the services delivered by the computer-and-communications (compunications) infrastructure have almost literally changed the shape of the United States. I next describe information resources in generic terms that permit comparing specific modes of information resources in terms of the key questions asked about any resource: who has it, who wants it, how can you get it, and what are the terms of trade? Vignettes of information resources in peace and war, in employment and productivity, in freedom and control depict how contemporary answers to these perennial questions are changing.

The Changing "Compunications" Infrastructure

Nineteen seventy-six marked the centennial of the telephone; the telegraph is a generation older. The births of radio early in the 20th century and of television in midcentury are other notable milestones in the evolution of the electronic communications technologies. Computer and other digital electronic information technologies flowered during and after World War II.

Wholly unprecedented is our still rapidly developing engineering mastery over the microscopic information processes embodied in devices such as large-scale integrated (LSI) circuits and microcomputers. The digital technologies underlying such devices are a merger of computer and communications technologies into a common stream that I have called compunications technologies.

Coincident with the unfolding of compunications technologies, political decisions began to be made in the late 1960's that awoke competition in the telecommunications industry where it had been dormant for half a century; in the same period the boundary between the telecommunications and computer industries grew blurry. The resulting price changes almost literally changed the shape of the United States. Figure 1a is a familiar geographic map of the United States marked with distances from Jefferson City, a place at about the center of Missouri. The less familiar maps of Fig. 1, b to d, are telephonic maps. Whereas the geographic map shows actual shapes with the circles showing miles, the telephonic maps show costs, not distances from Jefferson City.

Similar politico-economic-technological changes in our perceptions of distance—and of time—will continue globally over the next decade along with domestic and international battles over how the resulting benefits and burdens are to be shared among advanced or developing nations, big or little businesses, urban or rural households, and different types of uses such as the traditional and still dominant voice services from mouths to ears or the new and growing digital transmission services to and from compunications terminals at work or at home.

Concomitant changes in industrial organizations also can already be discerned behind a still stable facade of traditional labels. To help visualize these changes, John McLaughlin (*1*) has diagramed (Fig. 2) the operating spheres of two of today's industrial giants (AT&T and IBM) on scales independent of traditional industrial categories. Figure 2 shows that even today these spheres overlap more than might be suggested by AT&T's obsolescing "telecommunications" label and IBM's obsolescing "computers" label. But AT&T's and IBM's common reliance on common compunications technologies makes possible the still greater overlap shown as it has been derived from the ebb and flow of acquisitions or divestitures, business plans announced or withdrawn, regulatory petitions granted or denied, and legislation passed or tabled that accompanies a period of intense turmoil in turf definition.

What comes of that turmoil clearly matters to the numerous protagonists—such as AT&T, IBM or IT&T, the U.S. Postal Service, RCA, Exxon, Chase Manhattan, Dun and Bradstreet, McGraw-Hill, the Washington *Post*, and numerous other enterprises, large and small, public and private—in the United States and abroad who are redefining themselves and their missions in the light of technological changes that have lifted the traditional barriers among themselves and among their markets.

Beyond the stakes of particular corporations, some see the changing patterns

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of prices of information and of access to information as likely to entail pervasive and profound social transformation, just as the advent of mechanized industry and the subsequent rise of the bourgeoisie transformed Western societies once before. Hence such labels as the "information revolution," the "information society," or the "post-industrial society" (2).

It is generally recognized how significant changing modes of transportation are in commercial terms of access to raw materials, energy, labor, and markets or in terms of the projection of military power. Since it is less widely understood, the significance of changing modes of information resources is next described in similar terms.

Information Resources and Post-Industrial Society

Every society is an information society and every organization an information organization, just as every organism is an information organism. Information is necessary to organize and to run everything from a cell to General Motors or the Pentagon. Large organizations get information and use it through formalized functions that military commanders call intelligence and command-and-control and that civilian managers refer to as staff assimilation of information for line management. If an organism is taken as a metaphor for a group, corporation, military service, country, or society then, metaphorically, intelligence is the function of the outward senses and command-and-control encompasses all other functions of the nervous system, including inward senses. In organizations as in organisms the scope of these functions and the means for executing them range from the rudimentary to the highly elaborate.

Motor functions, those of muscles, weapons systems, or assembly lines, are, of course, essential to doing anything; they depend on materials and energy, and without materials there is nothing and without energy nothing happens. But without information, nothing has meaning: materials are formless, motion is aimless. Contrasting an information society to an industrial society therefore does not imply, as is often mistakenly supposed, that the intrinsic importance of motor functions is diminishing. It merely shifts focus from motor functions or physical actions to the nervous systems that direct the senses, thought, and physical action. The contrast also reflects a proportion of information-related activities greater in modern societies than before.

Nowadays major and rapidly growing industries either produce, distribute, store, or process information as their main product or else supply others with the means for doing so (Table 1). Almost half of the U.S. labor force is already engaged in information occupations (Fig. 3). Although highly visible institutions, most notably public libraries and commercial television, continue to foster the illusion that information is a free good, information resources do in fact cost something. They are also essential for planning, directing, and monitoring the purposive activities of organisms and organizations.

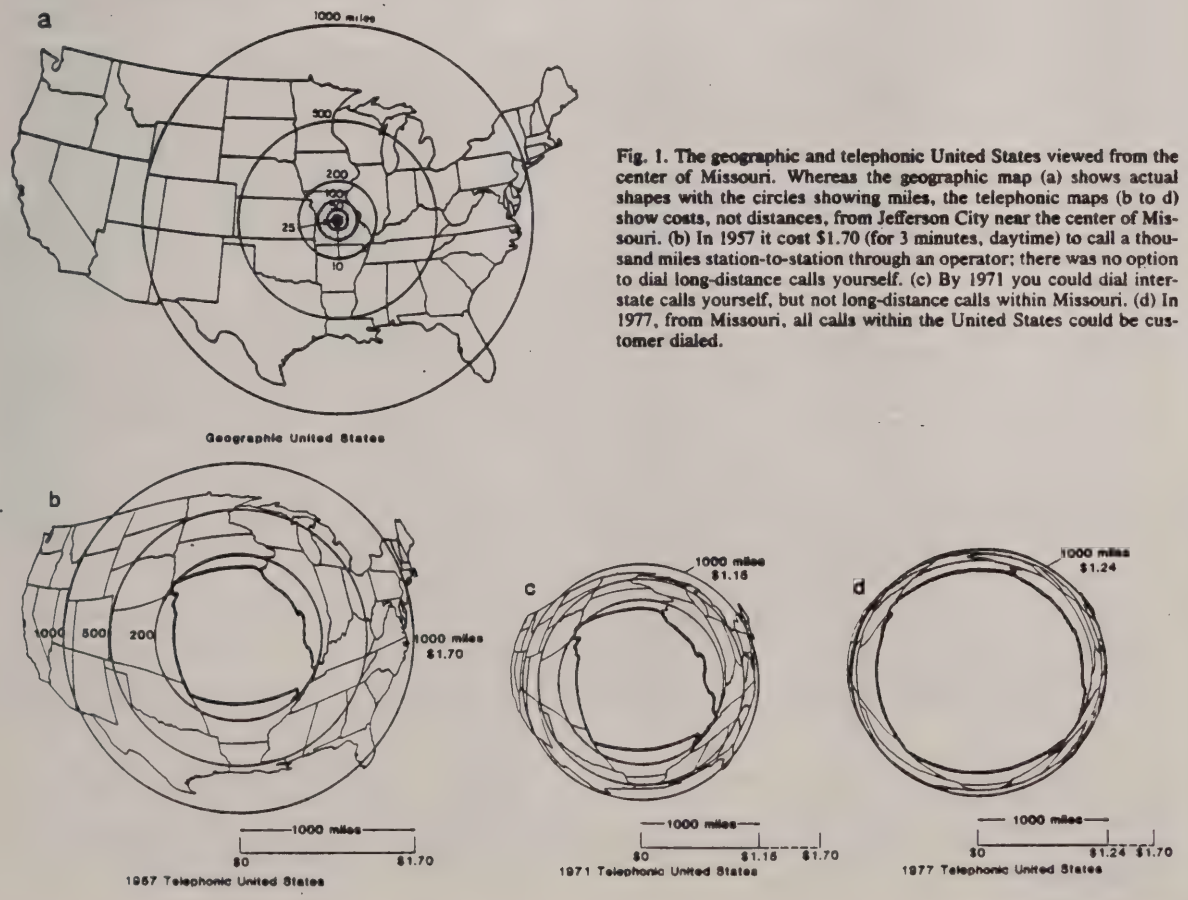

Fig. 1. The geographic and telephonic United States viewed from the center of Missouri. Whereas the geographic map (a) shows actual shapes with the circles showing miles, the telephonic maps (b to d) show costs, not distances, from Jefferson City near the center of Missouri. (b) In 1957 it cost $1.70 (for 3 minutes, daytime) to call a thousand miles station-to-station through an operator; there was no option to dial long-distance calls yourself. (c) By 1971 you could dial interstate calls yourself, but not long-distance calls within Missouri. (d) In 1977, from Missouri, all calls within the United States could be customer dialed.

Like materials and energy then, information is a basic resource and the critical questions about any resource also apply to information: who has it, who wants it, how can you get it, and what are the terms of trade? These questions are timeless; changing information technologies are changing only the answers.

Signs of the increasingly abundant fruits of modern information technologies are now all around us; witness, for instance, the many new and relatively cheap consumer products that *Time* magazine saw as evidence that America was becoming a "computer society" (Fig. 4).

The growing variety and versatility of information resources is masked by lingering traditional ties between specific kinds or purposes of information and specific means of dealing with them. Stereotypically, for example, news went with ink-on-paper and legmen, rewrite men, heroic editors with green eyeshades, massive presses, and little merchants staggering around the block under a Sunday's load. Mass entertainment was live hoofers on sawdust stages in the 1920's, silver halide images on celluloid projecting motion onto the screens of Art Deco movie palaces in the 1930's and 1940's, and phosphorescent images with commercials on the tubes in "home entertainment centers" since the 1950's. Personal communication for many still means ink, paper, envelopes, licking stamps, and the ring of the postman; for others, it's now mainly a finger in the dial or on the beeping buttons, the ring of the telephone and a voice at the other end. Dickens' Bob Cratchit and Uriah Heep are ancestors both of the keypunchers of yesterday's clerical warrens in banks and insurance companies and of the word processors sought in today's want ads. Digital compunications technologies already are versatile enough to discharge all of the above functions, certainly in part, perhaps entirely: all the different kinds of information can be represented in digital format, processed by computers, and transmitted electronically.

The term "information" appears to cover too much that seems distinctive: knowledge, data, information in a narrow sense that some treat as synonymous with data, news, intelligence, and numerous other colloquial and specialized denotations and connotations. However, the distinctions implied by oppositions such as observations/theories, data/knowledge, raw intelligence/finished intelligence, accounting details/management information are secondary, not fundamental in characterizing information resources. They reflect only relative judgments. For instance, one person's knowledge is often another's raw data. What a vice president for marketing, production, or finance thinks he knows is just data to the chief executive officer's staff. What a scientist thinks he knows about the merits of a flu vaccine or the safety of a nuclear reactor is just data for presidential policy and politics. Data or knowledge are just types of information content—of greater or lesser value, of greater or lesser cost.

Furthermore, information content comes to us in many readily interchangeable forms—pictures, words, speech, writing. These forms are representations of information content, as in the spoken representations of the word "car" in southern or in Yankee dialects, or the representations of "car" in cursive or block letters or in Morse code. And then there are formats of information content, the physical tokens that embody it: toe marks traced in the sand, gouges chiseled in stone, ink marks on paper, glowing phosphor patterns on television screens, electrical currents in

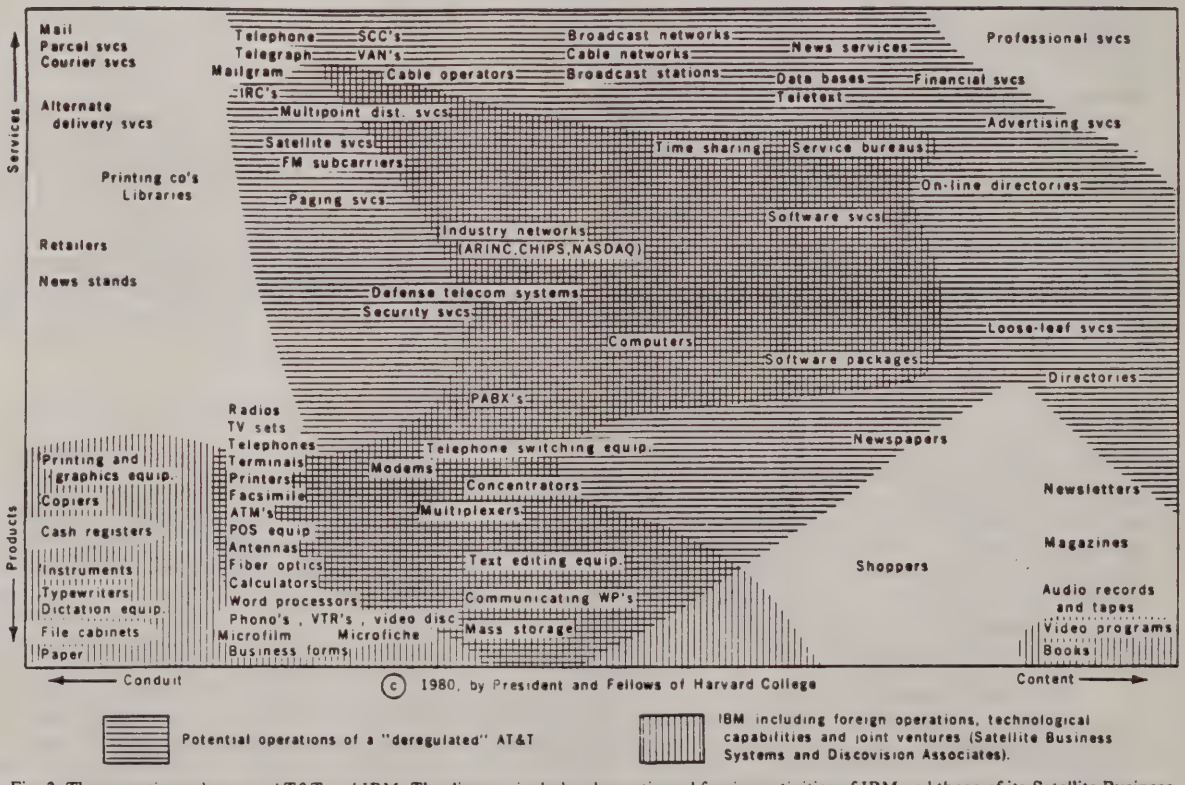

Fig. 2. The operating spheres at AT&T and IBM. The diagram includes domestic and foreign activities of IBM and those of its Satellite Business Systems and Discovision subsidiaries; it also includes AT&T's planned Advanced Communications Service. [From McLaughlin (*1*)]

telegraph or telephone wires, electromagnetic waves from satellites to Earth stations, magnetic bubbles in computer memories, laser beams in glass fibers. The processes of gathering, storing, manipulating, transmitting, evaluating, and using information content in various formats are mediated by physical processors such as pen and paper, printing presses, computers, and human brains.

It is only tradition that associates specific kinds of information content or purpose with specific representations, formats, and processors. In contrast, the generic concept of information resources encompasses any information content represented in any way, embodied in any format and handled by any physical processor. It encompasses any information processor for any content in any representation and any format, run within any public or private organizational structure. Adopting this generic concept enables us, as indicated above, to ask about information resources the same basic questions we ask about any other resource. It also enables us, as with other generic resources, to select specific modes for greatest effectiveness, efficiency, esthetic value, or any other criterion in order to get the most out of the potential of the vast panoply of information technologies now at our disposal.

The exploitation of diverse modes of information resources in the Iranian revolution of 1979 and the Iranian-American confrontation of 1979–1980 provides a pointed illustration.

Table 1. Annual gross revenues of the major information industries. Symbols: a, government statistics are routinely compiled for this industry but were not yet available for this year; b, industry statistics consistent with those for the following years are not available; c, major league sports are as intimately linked to the television industry as motion picture production and therefore qualify for inclusion. The organizations are, however, generally privately held and, except for a rare special study, data about them are not available; d, statistics are routinely compiled for only some types of libraries; e, figures are not normally released by the government but became available for prior years through congressional hearings.

Information industries	Approximate gross revenue (in billions of dollars)				
	1970	1974	1975	1976	1977
Telephone	18.2	28.3	31.3	35.6	40.8
Telegraph	0.4	0.5	0.5	0.5	0.6
Specialized common carriers	0.0	0.0	0.0	0.1*	0.2*
Satellite carriers	0.1	0.1	0.1	0.2	0.2
Mobile radio systems	2.0	2.9	3.2	3.5	a
Postal service	6.3	9.0	10.0	11.2	13.0
Private information delivery services	0.7†	1.3†	1.6†	1.7†	2.4†
Pulp, paper, and board	13.0†	17.1†	a	a	a
Photographic equipment and supplies	3.9†	6.0†	a	a	a
Radio, TV, and communication equipment	12.8†	16.8†	a	a	a
Electronic components and accessories	12.8†	20.3†	a	a	a
Computer systems manufacturers	b	16.6	18.8	21.1	23.8
Computer software and service suppliers	1.6	3.2	3.8	4.5	5.3
Broadcast television	2.8	3.8	4.1	5.2	5.9
Cable television	0.3	0.6	0.7	1.0	a
Broadcast radio	1.1	1.6	1.7	2.0	a
Motion pictures	3.8	5.5	5.4	a	a
Organized sports, arenas	1.0*†	c	c	c	c
Theaters	1.5	2.5	2.7	a	a
Newspapers and wire services	7.0	9.6	10.5	11.7*	13.4*
Periodicals (including newsletters)	3.2	4.1	4.4	5.0*	5.6*
Business consulting services	0.9	1.7	1.8	a	a
Advertising	7.9	9.7	10.0	a	a
Brokerage industries	40.6	64.0	69.1	a	a
Book publishing and printing	3.4	4.5	4.8	5.2*	5.6*
Libraries	2.1	d	d	d	d
Schooling	70.1	97.7	110.8	121.4	130.6*
Research and development	25.9	32.7	35.1	38.5	42.7*
Federal information institutions					
Census Bureau	0.1	0.1	0.1	0.1	0.1
National intelligence community	4.0*†	7.0*	10.0*†	6.0*†	e
NTIS‡	0.0	0.0	0.0	0.0	0.0
Social Security Administration	1.0	1.9	2.2	2.6	2.7
County agents, government	0.3	0.4	0.4	0.5	0.5
Banking and credit	61.1	136.2	132.7	a	a
Insurance	92.6	133.1	148.8	a	a
Legal services	8.5	13.7	14.8	a	a

*Estimated. †Lower bound. ‡National Technical Information Service.

Abundance and Variety: Iranian and American Experiences

Shortly after Ayatollah Khomeini's people took over from the Shah of Iran early in 1979, the Washington *Post* reported that they had cut off international direct dialing, requiring all international calls to go through operators instead. Apparently the Khomeini regime did not wish to be done to as it had done to the Shah, namely be leveraged out of power with command-and-control coordinated locally and abroad through the domestic and international automatic telephone network and other channels.

Indeed, the dog did not bark before the Shah's ouster early in 1979: the takeover of the main radio and television stations, that hallmark of the stereotypical coup, did not take place. There was no need for it. The Shah was in control of the best of traditional media to a degree that Roosevelt, Churchill, Hitler, Mussolini, or Stalin might have envied. But these media no longer mattered as much to national communications as in their heyday when alternatives were far more limited. Khomeini's people struggled, as one wag put it, "against autocracy, for democracy, by means of xerocracy" using abundant and accessible modern and ancient consumer media, not the scarce and inaccessible mass media ascendant in the 1930's through the 1960's. Khomeini's messages went from France to Iran and within Iran by direct dial telephone and by mail or courier. Audio cassettes of the Ayatollah's exhortations were widely disseminated for use on relatively cheap, hence widespread, common cassette players. In addition, their contents were transcribed and widely photocopied on, by then, common dry copiers. Word of mouth did the rest through imams in the mosques.

Toward the end of 1979, when Iranian "students" took over the American Embassy in Teheran and held its staff hostage, there was further evidence of eclectic fitting of modes to ends. The Iranians took advantage of the satellite tech-

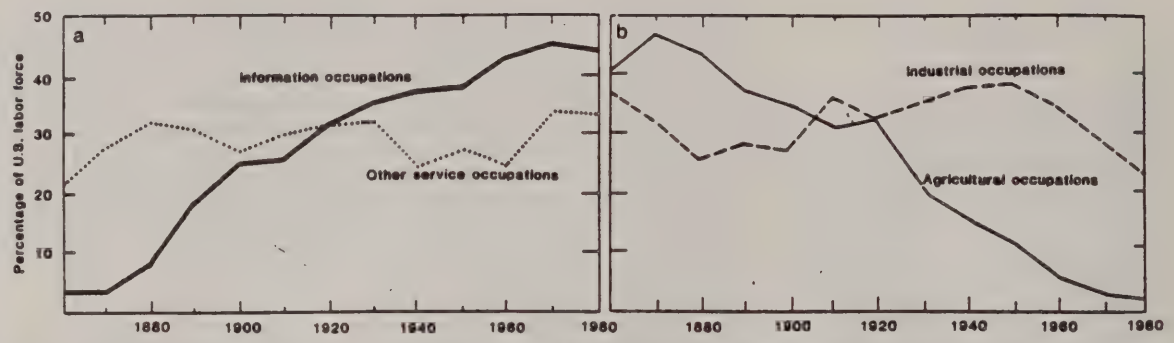

Fig. 3. Trends in the composition of the U.S. labor force. (a) Rising information occupations; (b) falling industrial and agricultural occupations. [From Porat (*14*)]

nologies and the open institutional traits of American television to stage for American consumption a running media event similar to domestic American events in the Vietnam and Watergate periods. Americans, on the other hand, took to the telephone network for contacts with Iranians and Americans in the embassy and engaged in massive exploitation of the old-fashioned mail system to shower Christmas cards on the hostages. And on Christmas Day, besides the imams in the mosques, there were clergymen in the embassy. With the muscle of naval task forces in the wings a large cast of ancient and modern information resources held center stage.

Eyes and Ears of Peace

In the early 1950's cloak-and-dagger intelligence-gathering and covert operations of World War II vintage were still in full bloom. Retrospectively far more significant, however, was the news in 1960 that the Soviet Union had captured Gary Powers and his U-2 reconnaissance aircraft. President Eisenhower's embarrassment was a bow to the old ways, but his proposal of an open skies policy presaged the new: information resources have since become a key element in averting the use of nuclear weapons from the Cold War to the present. The role of new information resources will continue to grow in strategic peace-keeping, in the command and control of military operations on any scale from local skirmish to global Armageddon, and in the management of peacetime crises like the oil embargo of 1973.

The *New York Times* in August 1979 reported that high-technology-based information systems "have given the American intelligence community an unsurpassed capacity to peel away the layers of secrecy that have traditionally surrounded the Soviet Union's military establishment" (*3*), and the *Times* illustrated its point with this vignette:

> A hundred miles above central Asia, an American satellite suddenly switches into operation. Although it is the dead of night, the spacecraft's camera takes hundreds of photographs of a suspicious construction site near a Soviet intercontinental ballistic missile complex. Minutes later as the satellite passes over Australia, the infrared photos are transmitted to an American-operated ground station and then relayed to the Central Intelligence Agency in Langley, Va.
>
> Examining the heat-sensitive images with the aid of computers using photo enhancement techniques developed in planetary exploration, C.I.A. analysts quickly note that the ground temperature of the construction site is substantially warmer than the surrounding terrain. The evidence appears conclusive: The Russians have secretly begun building an underground silo in which to house a new, multi-warhead missile.

Earlier, in 1972, overflights and other procedures such as had embarrassed Eisenhower had already begun to take the limelight. The treaty on the limitation of antiballistic missile (ABM) systems that emerged from SALT I provided that

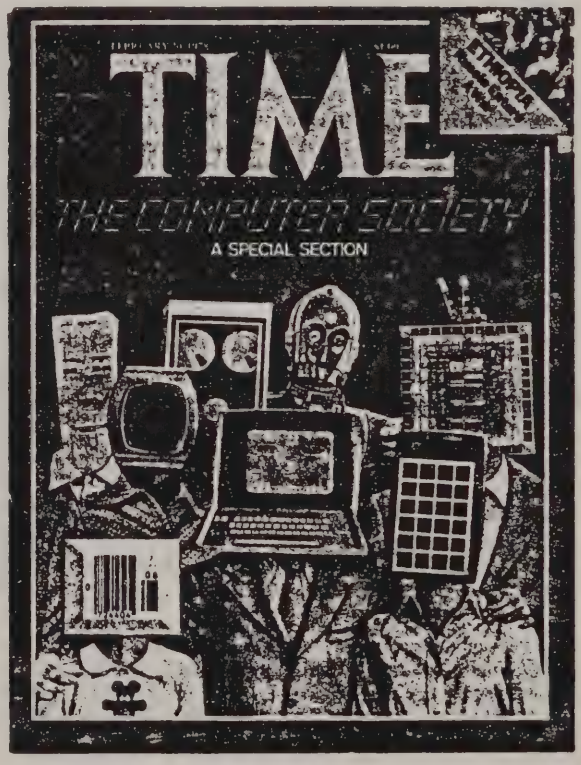

Fig. 4. Consumer products. [Reproduced by courtesy of Time Inc.]

"each party shall use national technical means of verification at its disposal consistent with generally recognized principles of international law," that "each Party undertakes not to interfere with the national technical means of verification of the other Party," and that "each Party undertakes not to use deliberate concealment measures which impede verification by national technical means" (*4*).

The seminal character of these arrangements of 1972 is underscored by the use of similar language in the 1974 treaty limiting underground nuclear weapons tests and in the 1976 treaty on underground nuclear explosions for peaceful purposes, and by the elaboration of that language in the SALT II treaty on the limitation of strategic offensive arms as negotiated by mid-1979.

The biblical metaphor of beating swords into plowshares builds on homely muscle functions of biblical times. A future version might build on information functions. Agreements in 1973–1974 ending the Yom Kippur War between Israel and Egypt relied on a traditional territorial buffer zone with a United Nations Emergency Force stationed in it. By 1975, however, Secretary of State Kissinger's shuttle diplomacy had led to a new agreement wherein aerial reconnaissance and early warning and surveillance functions were entrusted to American civilian personnel and technical facilities.

At a time when American memories of Vietnam were still fresh, this innovative expedient may have had as its principal goal easy authorization by the Congress of an action that committed, not U.S. Armed Forces, but "United States civilian personnel to carry out specified noncombat functions" (*5*) as volunteers. By May 1978, however, Vice President Mondale's speech (*6*) to the United Nations generalized the experience in the following terms:

> Our experience in the Middle East has demonstrated that technical assistance with monitoring systems, such as aerial photography and ground detection devices, can help create the confidence necessary to make disengagement and stabilizing agreements work.
>
> Building on that experience, we are prepared to consider joint requests for these "eyes and ears of peace" from countries that want such monitoring services. Such requests should come preferably via regional organizations or the United Nations.

It is doubtful that national technical means or surveillance sensors have been significantly effective in slowing down the U.S.-Soviet arms race or, by themselves, in cooling down Egyptian-Israeli passions. However, the fact that the muscle functions embodied in nuclear weapons and their delivery vehicles have not been exercised in anger from Hiroshima to date and that orderly disengagement occurred in the Sinai may be attributed in substantial though far from exclusive measure to the stabilizing role of information resources in reducing the probability of accident or surprise.

Command and Control in War

Should muscles have to be exercised, their successful use likewise depends on the functioning of technical means of intelligence, command, and control. As a former President's Science Adviser, Edward E. David, Jr., put it in a *Science* editorial on SALT II (*7*), there is, for peacekeeping, a need for intelligence "that provides current, accurate information for the President and avoids putting him in a position where precipitate action based on presumptive information is needed to prevent loss of a military force under attack." There is also "the necessity for assured command and control of strategic forces" for, otherwise, "the President could lose control—the forces might not be launched or might be launched by a lesser authority."

Tensions will continue because of the close kinship among the technical means used for sometimes antithetical purposes—keeping peace or waging war, gathering intelligence or mapping agricultural and mineral resources, providing communications for trade or for military command and control. This is evident from the following testimony on the SALT II agreement by Secretary of Defense Harold Brown (*8*):

> To monitor Soviet compliance with the provisions of SALT II, we employ a set of intelligence capabilities known as "national technical means." This general term covers a variety of methods for monitoring Soviet military activities, including photographic satellites and other technical collection means. These systems enable us to monitor, for example, Soviet telemetry—technical data transmitted by radio signals from the Soviet missiles during tests—from outside Soviet territory. Other examples of national technical means include the ships, aircraft, and land-based radars used to monitor Soviet missile testing.
>
> This is not a complete list of the technical devices that constitute our national technical means. Still less is it a complete list of all U.S. intelligence resources. Many of our intelligence resources are very sensitive, and public acknowledgement of their capabilities would make it far easier for the Soviets to negate them. For that reason, public information about the details of our intelligence facilities and capabilities is quite limited. Although there have been a number of discussions in the media about our intelligence sources, it would not be in the nation's best interest to comment publicly on the accuracy of reported capabilities.

Eavesdropping and Privacy: Blurring Traditional Boundaries

In general, an increasingly widespread technological base has blurred many traditional ideological or organizational distinctions that once were justifiable by technological differences. For example, the age-old concern over privacy in many realms is once again conspicuous, partly because of the social and political milieu of the late 1960's and early 1970's but also because of the widespread availability of cheap and effective technical security measures—both intrusive and protective—based on digital compunications technologies. The following is only one of many possible illustrations.

Traditionally encryption was mainly used by governments for diplomatic or military affairs, although techniques more rudimentary than what governments could afford were used by private parties, as in the communication of sensitive commercial or banking transactions. No longer. In what he called an unprecedented public address early in 1979 about his agency's responsibility for the "signals intelligence" and "communications security" functions of the U.S. government, Admiral B. R. Inman, the director of the National Security Agency (NSA), described the new climate as follows (*9*):

> . . . Concern for the protection of communications, which for many years was viewed as being of interest solely in reference to government national security information, has now expanded throughout the government and to various important segments of the private sector. In the process there has developed a new and unprecedented nongovernmental interest in cryptology and in communications security. Expanded telecommunications protection activity, both governmental and private, has in turn led to an encounter between the activities of NSA and those of other governmental and private entities and individuals that in many ways is novel.
>
> . . . There has been a growing public concern over the protection of data generated by or stored in computers. The public has become increasingly aware of the danger that automated data processing systems, if not adequately protected, can be exploited for fraudulent and illegal purposes. Moreover, the vast amounts of personal information stored in and handled by automated data systems, both private and governmental, has given rise to serious concerns about individual privacy.

The particular problems of protecting telecommunications and data banks, both private and governmental, illustrate the generic questions that arise when an issue crosses traditional boundaries. The organization of American government agencies tends to mirror certain distinctions that are deemed significant, if not semi-sacred: the distinction of the domestic from the foreign, the civilian from the military, and the private from the public. But, as Greg Lipscomb (*10*) suggests, modern interception technologies seem irreverent of these boundaries.

What is domestic and what is foreign? In 1970 NSA is reported to have picked up information about Korean government payments to members of Congress long before the payments became an issue in American domestic politics. The information, although of a domestic nature, was gathered while intercepting electronic cable traffic of the Korean government. Where does the domestic separate from the foreign here? Similarly, of what effect are domestic privacy laws if domestic long-distance communications, beamed through satellites, can be picked up by Cuban antennas or Soviet offshore ships, as they apparently can?

What is civilian and what is military? In 1977, according to news reports, NSA approached a private telecommunications company with an offer to "enter into a 'classified contract' under which the government . . . would assist the private company to improve its defenses against eavesdropping" (*10*, p. 14). This can be seen as reasonable for both parties. NSA, after all, is responsible for securing the government's communications and has possibly the most sophisticated telecommunications capability in the country. But NSA is also part of the Department of Defense and its move could also be said to violate traditional boundaries. In developing their response to Soviet electronic eavesdropping on the United States, Administration officials are reported to have stressed that they "didn't think it appropriate to have the Department of Defense controlling the private sector" (*10*, p. 14) and that "the agency's action was surprising and appeared to go beyond its normal range of concerns" (*10*, p. 14). The line between the civilian and the military seems to have grown thin in this instance.

What is public and what is private? The telecommunications industry in the United States is privately held. Moreover, competition and diversification have been encouraged within the last decade through decisions of the Federal Communications Commission (FCC). These decisions permit anyone to attach terminals to the common carrier network and also permit new and competing microwave or satellite networks, such as Satellite Business Systems (SBS), to enter the market. With such private diversity, who assumes responsibility for foreign intrusion, an essentially public problem? At what point does private information become so strategically significant that its availability to foreign powers could jeopardize national security? Who determines such a status and what, if anything, should be done about it? Should the umbrella of the government's uniform classification system be radically changed to include such information? By what means? By whom and by what criteria? Another traditional distinction, this one between the public and private sectors, seems to have grown blurred.

United States thinking about information resources nonetheless has generally remained channeled within traditional though no longer distinctive categories. In contrast, Canada has a more comprehensive approach that cuts across categories and is integrated into the mainstream of its political, economic, cultural, and legal thinking. Perhaps this is due to a keener perception of the importance of information resources to Canada's three main concerns as a nation: unity, economic viability, and cultural identity.

Employment and Productivity

To round out our picture of changing answers to the perennial questions about information resources, it is therefore helpful to draw on analyses, developed by Oswald H. Ganley (*11*), of the role of information resources in Canada and of their influence on U.S.-Canadian relationships.

The possibility of rapid, massive, and cheap flow of data across borders and the preeminence of the United States in compunications-based facilities and services has led other countries to worry about transborder data flows (TBDF). Western European governments justify these concerns in terms of individual privacy. Canadian government and industry recognize them as essentially economic, a matter of lost jobs, negative balance of payments, and lost top management opportunities. What restrictive or permissive legislation develops on this score around the world is expected to have an impact on worldwide job markets.

Domestically as well, there is concern over productivity in information occupations—that is, in jobs that are managerial, clerical, educational and the like as distinguished from plowing, metal-cutting, or other "muscle" occupations. Interpreted one way, Fig. 3 can justify attributing past gains in industrial and agricultural productivity to increasing use of information resources in order to do more with less of other labor and perhaps other capital resources. Interpreted another way, it suggests that information occupations are now the least productive, hence the ripest for displacement by more capital-intensive information resources based on the compunications technologies whose costs are dropping in the face of rising costs of all labor and of other capital goods. The possible implications are not perceived as dramatically in the United States as they are in Canada or in France. A 1978 report (*12*) to France's President Giscard d'Estaing states vaguely but portentously:

> Should France fail to develop an appropriate response to certain new and serious challenges, her domestic tensions will deprive her of the ability to control her destiny.
>
> The growing "informatization" of society is at the heart of the crisis. It can exacerbate it or contribute to resolving it. Depending on what policies will enfold it, it will bring forth the best or the worst; its effects are neither automatic nor inexorable. They will depend on how relations between government and society will evolve in the years to come.

Research and development in high-technology industries, microelectronics and computer software especially, has also been at issue, since the Canadian government has expressed displeasure over the low level of research and development performed by U.S. subsidiaries in Canada and the heavy U.S. ownership within the Canadian electronics industry, sentiments analogous to growing concerns of U.S. industries vis-à-vis Japan.

Information Freedom and Control

The Canadian government perceives Canada as being overwhelmed by American media content that robs Canada of its national identity. Directly, this mainly affects such American industries as publishing and broadcasting. But similar perceptions as expressed in Third World demands for a New World Information Order pit the restrictionist impulses of most of the world against an increasingly isolated American devotion to a principle of free flow of information. The resulting clashes have not only economic over-

tones, but also ideological themes. The Mass Media Declaration adopted by Unesco in 1978 failed to legitimize inclinations to exclude, control, or expel foreign journalists working within a nation's borders only because of strenuous U.S. objections.

The possibility of broadcasting directly to homes via satellites raises similar issues. Canada wants to have domestic television broadcasts direct from satellites as an economically attractive alternative to local transmitters spread throughout the sparsely populated land mass north of the band along the U.S. border where most Canadians live. But, along with other issues, this possibility raises the specter of importation to Canada of even more U.S.-made content than at present. Globally, many nations believe that direct television broadcasting by satellite from one country to another without the prior consent of the receiving state is a violation of national sovereignty. The resulting conflict between the principles of free flow of information and of national sovereignty is fueled by the fear, expressed by many states, that the United States would use its great technological advantage in this area for political, cultural, or commercial purposes. The commercial exploitation of Landsat satellites for agricultural and mineral resource mapping, already complicated by potential conflicts with intelligence interests and by questions of public versus private, monopolistic versus competitive ownership structures, is subject to similar fears.

Domestically, battles are shaping up over how to interpret the First Amendment as it applies to the numerous hybridized and competing forms of compunications-based services now offered under such labels as cable television, teletext, database publishers, and the like. Issues here are further complicated by the fact that, in this new era of abundant and versatile compunications, the traditional institutional media—newspapers, radio, television—no longer hold exclusive command over mass communications technologies. Any political candidate, for instance, may find a bank of telephones (with computerized rapid dialing) or a computerized mailing list to be a greater communications asset than editorial endorsement by a newspaper.

Consider the following hypothetical situation framed by William H. Read (*13*):

> The legislature of State X has before it an omnibus tax reform bill that, if enacted, would give individual taxpayers some relief while greatly increasing the tax burden of corporations. Suppose further that the entire business community, including local media corporations, oppose the bill because of the detrimental impact it would have on their post-tax profits.
>
> Do corporations have a First Amendment right to speak out against such a bill? Yes, said the Supreme Court in *First National Bank of Boston* v. *Bellotti*. But their rights differ. The corporation that owns the local newspaper can frequently and freely editorialize in that paper against the bill. The corporate broadcaster, however, cannot express himself over-the-air even once without triggering affirmative Fairness Doctrine obligations. But what about, say, the local telephone company? What if that corporation decides to put its views before the public by printing a political message on its customers' monthly bills, or more likely by inserting such a message in each billing envelope? As a matter of constitutional law, could the State's public utilities commission stop this practice? If not, could the state commission compel the phone company to distribute opposing views, too?

Under the 1978 decision in *First National Bank of Boston* a telephone company or any other corporation has First Amendment rights. But what is the scope of those rights? In the hypothetical situation posed is the corporate mailer free from right-of-reply requirements as newspapers are, or are phone companies, banks, and other businesses to be fitted into the broadcast mold? The answers to such questions will carry the relation of knowledge to power forward into the 21st century.

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SPECIALIZED C-I-K FACILITIES;
TWO SUMMARY PROPOSALS

BAY CITY CENTRE

A parcel of land covering two blocks of downtown Boston represents a development opportunity that can tie Boston's high-technology industry to the city's growing video communications industry.

The Bay City Centre parcel is 185,000 square feet of land bounded by the major downtown traffic arteries of Tremont Street, Stuart Street, Washington Street and Boylston Street.

More importantly, the parcel is bounded by the Park Plaza project, where a $90 million State Transportation Office building and $32 million, 200-room Four Seasons Hotel is under construction; the $140 million Lafayette Place project, with its retail arcade and 500-room Intercontinental Hotel; the Tufts University/ New England Medical Center; Boston's Chinatown; and Boston's Theatre District.

The site's five development parcels can accommodate an office tower, residential building, low-rise office and retail building, a communications-media center and a public pedestrian way.

The element which adds so much excitement to this development is a concept embodied in the Boston Communications Technology Center. Boston is the sixth largest television market in the country. It is also the home of WCVB-TV/ Metromedia, the fourth largest "network" in America, and WGBH-TV, a public television station known for its locally-produced programs. The state-of-the-art cable system now being installed in Boston also adds to Boston's likelihood as a production center for quality television programming.

Because Boston is at the center of America's high-technology industry, a unique opportunity exists to apply the research and development expertise of these businesses to Boston's new 200-channel interactive cable system. In doing so, the Center

could accommodate both cultural and commercial programming demands, particularly with the cultural and educational resources which exist in Boston.

However, the Communications Technology Center, will be only one component in a project that will include a 600,000 square foot "theme" tower, which will overlook the Boston Common, as well as 240 residential units, and a low-rise structure that will have retail outlets on the street level. A landscaped pedestrian way will run at a diagonal through the site, thus linking the Washington Street retail area to the city's Theatre District.

Development Area

Residential Parcel	22,175 s.f.
Office Parcel	43,356 s.f.
Retail/Office Parcel	10,392 s.f.
Media Center Parcel	29,871 s.f.
Public Way Parcels	80,000 s.f.
Total Development Area	185,000 s.f.

Development Schedule

Residential Parcel	1986 - 1988
Office Parcel	1983 - 1986
Retail/Office Parcel	1984 - 1986
Media Center Parcel	1983 - 1985
Public Way Parcels	1983 - 1988

INTER-OFFICE COMMUNICATION

TO Robert J. Ryan, Director

FROM Bill Condo Bill C

DATE July 27, 1982

SUBJECT COMMUNICATIONS TECHNOLOGY CENTER

As we have compiled information and refined the concept for a media center that would serve as a focus for the video industry in New England, it also is apparent that the proposed facility should be all encompassing in terms of services for electronic communications. Because of the nature of Boston advertising and television programing, we have not developed an array of specialized video facilities to serve segment of the market. Instead, facilities such as WGBH, Centel Studios and Videocom are general use in nature; providing productions - post producation, audio, mobile units and technical services.

In this regard the Communications Technology Center model should also reflect a full array of services for electronic communications, including facilities that do not now exist in the Boston video industry.

Based on the information we have accumulated, our model would consist of the following components.

- A 70,000 s.f. facility on a 40,000 s.f. site, within Parcel 31.
- Two 40' x 40' studios
- One larger shooting stage, potentially utilizing the Publix/Gayety Theater for live performances. (while there is no documented need for such a stage, everyone seems to indicate we should plan for such a facility).
- 30,000 s.f. of office space for the 60, full time technical and administrative staff that will run the Center.
- Film laboratory (none exists presently)
- Recording studio (digital sound) with sound transfer capabilities.

- Teleconferencing center for business use.
- Two technical training/classrooms
- Two screening rooms
- Mobile video and recording capability.

Our model, including these services, will in itself attract talent and may expand the multiple media production potential that already exists in Boston but goes elsewhere because of deficiencies in the existing industry. We can estimate that the investment level in such a facility to be approximately $15 -20 million.

Again, in our investigation of existing production facilities in the Boston area, there exist some serious gaps in the talent and hardware available to meet the market demand for video products, either in video hardware or software. The Communications Center will substantially fill that gap to the degree that the Boston and New England market can find a New York or L.A. level of sophistication in the proposed facility.

Market Orientation and Development Potential
Boston Communications Technology Center

FEBRUARY 1982

Introduction

It is evident that Boston, through its recent cable television franchising process, is at the center of the telecommunications revolution which is sweeping the country. Presently, it is estimated that 25% of the nations households, representing some 22 million homes, subscribe to cable service, and by 1985 that figure will approach 35%.

While cable programming was primarily based on a 24 hour movie, news or sport format, it is now recognized that almost every form of entertainment, education and business information will be utilized to attract and inform the national and international market place. Additionally, while advertising revenues were only $50 million for 1980 (compared with network television's $5 billion), it is predicted that cable ad revenues will exceed $585 million by 1985 and $2.2 billion by the end of the decade.

The program suppliers for cable include some of the nations biggest corporations. Getty Oil, Times Mirror, Westinghouse-ABC, Time Inc. and, most recently CBS and 20th Century Fox joined forces to produce programming for both commercial and cable television.

As a technological parallel force to expanding cable systems, the personal and business computer, with its video screen, has become a multibillion-dollar industry for America's high technology companies. Almost three million personal computers are expected to be sold in 1982 and an estimated 50 million will be in operation by 1985 according to projections developed by Commodore International, a leading manufacturer. The entrance of IBM and American Telephone and Telegraph will further stimulate competition for this product.

Perhaps the most important aspect of the explosion in home and office computers for the Boston Communications Technology Center is the software, or programming that will be produced for the product. Again, education and training, consumer items, office communications and transactions, entertainment and security systems represent a small part of the almost unlimited programming that will be produced and available for the computer market.

Locally, Wang Laboratories has introduced WANGNET, a communications network cable that utilizes standard CATV as the transmission medium.

It is the combination of these two major industries, cable television and hign technology, that has resulted in the emerging unique concept identified as the Boston Communications Technology Center. It is a concept which will require the participation of local television broadcast stations, Cablevision/Boston and Massachusetts high technology companies.

It should be noted that several local video production/broadcasting operations are expanding their entry into the programming market.

Local Developments in Boston

. WGBH - Boston's public television station, is marketing its extensive facilities for commercial and cable television and video advertising. Additionally, they are pursuing telelext, videodisc and video conferencing. GBH is said to be negotiating with Cablevision/ Boston to develop programming and use its studio space. Among the facilities offered by GBH are:

- Computer controlled 1 "editing
- CBS color correction/Noise reduction
- Two-camera mobile unit
- 60' x 100' television equipped studio
- Film Editing facilities
- Diverse staff talent.

. Centel Studio - a three story, 15,000 s.f. one stop video production facility geared for commercial audio and video production. Facilities include:

- 30' x 60' shooting stage
- 1' and 2" editing equipment
- Videodisc and cassette recording equipment
- Graphic department, set design and construction
- Mobile unit

Centel is presently planning to add a larger studio space to its facility.

. Videocom - a full service videotape and motion picture production facility located in Dedham. Videocom offers:

- 60' x 40' studio
- Mobile unit
- Videocassette duplication
- Total post-production services ranging from editing through TrafficKing

- Full staff of directors, cameramen, soundmen, set and costume design and pre-production services.

Videocom does many commercials and training films for high tech companies, particularly Digital Equipment Corp. and is interested in expanding into downtown Boston.

Video Developments in Other Areas

- California Cable Systems : a subsidiary of the largest cable owner-operator in the world (Canadian Cable System) has agreed to a minimum investment of $ 750.000 into co-productions with a local, city (L.A.) owned legitimate theater. The resulting theater productions will be marketed to cable networks.

- The Port Authority of New York and New Jersey have hired Arthur D. Little, Inc. to study the market for "teleport" a communications center for businesses in Metropolitan New York that would link them by satellite to other businesses and around the world.

- J. Walter Thompson U.S.A. and Adams - Russell Co., a Peabody, Mass. cable operator, have entered into an agreement to test an interactive advertising and information service known as the Cable Shop.

- Jerome and Alan Minskoff, Broadway Producers, have joined with real estate developers to convert a former New York City high school into a $50 million television and film production Center. The building will provide 200,000 s.f. of space and is billed as the largest audio-video-film facility of its kind on the East Coast.

The Boston Communications Technology Center

In February 1981, consultants to the Redevelopment Authority completed an analysis of selected media production centers throughout the United States and recommended a model for the proposed Boston facility. Locations inspected by the consultants included:

1. CBS Television City, Los Angeles - A major television production complex coverin 9 acres and containing 4 major 80' x 100's studios, set construction shops and substantial areas for support activities close to 1200 employees work at the complex. Television City is a unionized facility.

2. Trans America Video , (TAV), Los Angeles - Studio space is limited to a small, theater-style operation which seats 150 people. The facility concentrates on high-quality, post-production and sophisticated remote television taping vans and trucks; which accounts for almost half its annual income. TAV has minimum staffing and enjoys a favorable union situation.

3. Opryland Productions, Nashville Includes the Opry Theater which seats 4000 and the largest radio studio in the world. A major television studio, control rooms and set construction areas have been recently built on the site. Production facilities are booked for two years in advance by networks and independent producers. The facility is not unionized.

4. Astoria Studios, New York City- The complex is one of the largest in the country with a 200' x 200' sound stage under construction. The restored facility will include both pre and post production space, film-to-tape transfer machines, multi-track audio taping, video duplications and recording studios. It can be assumed that the facility will be unionized.

Other operations surveyed by the consultants include the 90,000 s.f. Osmond Studios in Utah, the Los Vegas Hilton which contains a 700 theater type showroom used for television taping and AMZ Video, Los Angeles, a company that exists on film to tape transferring.

The Consultants, headed by George C. White, recommended a 75,000 s.f. Boston Media Center with three studios ranging from 125' x 150', 75' x 100' and 50' x 50'. The remaining space would be utilized for post-production, staff and mobile unit storage and activity.

Other factors taken into consideration to determine the economic and physical feasibility of the Boston Communications Center were statistics compiled by the Massachusetts Film Bureau which indicated that 73 local production facilities contributed approximately $27 million to the state's economy in 1981. These producers earned more than $17 million in gross income and paid out more than $5 million in salaries to 650 employees.

These producers, according to the report, suggested the need for high quality, post production facilities and the development of a major sound stage. With growing decentralization of the entertainment industry and the growth of cable, the area of video production was viewed as having unlimited potential locally.

Additionally, Boston ranks as the fifth largest legitimate theater center in the country. In a 1981 report of the Boston Redevelopment Authority, it was documented that 1-3 million people attended theaters in 1979-80 season and spent approximately $16 million over the cost of tickets on activities associated with their theater attendance. Preliminary figures from the 1981-2 season, which includes the first year operation of the 4,200 seat Metropolitan Center, indicate that the number of theater patrons rose to approximately $1.8 million.

It is important to note that several theater operators have recognized the importance of video production as a growing part of their future survival. Unique companies such as the Opera Company of Boston, the Metropolitan Center and The Shubert Organization have all expressed interest in mounting both legitimate and for video productions that will have a Boston flavor.

Finally, Boston is the sixth largest television market in the nation, and one of the most sophisticated. In 1980, the six television stations in Boston earned a combined profit of $36.6 million on revenues of $132.8 million. WCVB, Channel 5, earned about 35 percent of that total, or $12.8 million. Channel 5 has also been the leader in local origination programming, devoting 62 hours a week, which is more than any other affiliate in the country.

As a seperate but most important aspect of the local climate for video production, it should not be overlooked that the First National Bank of Boston is the largest banking institution in the country that makes loans for movies, television and legitimate theater productions.

From this accumulated information, it may be stated with some certainty that Boston can indeed support the creation of a complete, fully staffed and equipped media facility with the added benefit of high technology business application. It is projected that the facility of approximately 55 - 65,000 s.f. should offer the following services:

a) Production facilities: at least one major studio and possible additional smaller studios which can be used for both film and video.

b) Post-Production facilities: advanced film and video editing, audio, transfer and finishing equipment. Such equipment could be available for tenants as well as on a for-lease basis.

c) Facilities for film and video screening, distribution functions and equipment rental.

d) Communications Center: a centralized location for the origination and use of video communications equipment including broadcasting and teleconferencing.

e) Film processing lab.

f) Communications technology marketing center: space for the display and demonstration of new communications hardware and software.

With the inclusion of these media services in the proposed Boston facility and based upon the identified market potential of the area's cultural, academic, medical, advertising, business and high technology interests, the financial feasibility and use characteristics of the proposed Boston Communications Technology Center would appear to be positive.

The key to instituting activity aimed at realizing the facility will now depend on the interest and commitment of identified participants including, Cablevision/Boston, WCVB Channel 5, Metromedia and Videocom, Inc.

The proposed facility also cannot be separated from the larger development concept, identified as Bay City Center, which will include a major office tower, luxury housing and quality retailing outlets. The developer of this mixed-use site will play a key role in determining the initial stages of the Communications Center. The strength and creativity of this developer, combined with the resources of the entity which will own and operate the media facility, are critical factors that the City/BRA will consider in its continuing efforts to establish Boston as a major national center for media production.

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